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Quarterly

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Acme

Gasoline vapor explosion, New York City garage, October 3, 1949. Building wrecked, two men injured. Underground gasoline tank overflowed into building when overfilled from a tank truck. Gasoline escaped from tank gauging opening inside building.

The Quarterly

Vol. 43 October, 1949 No. 2

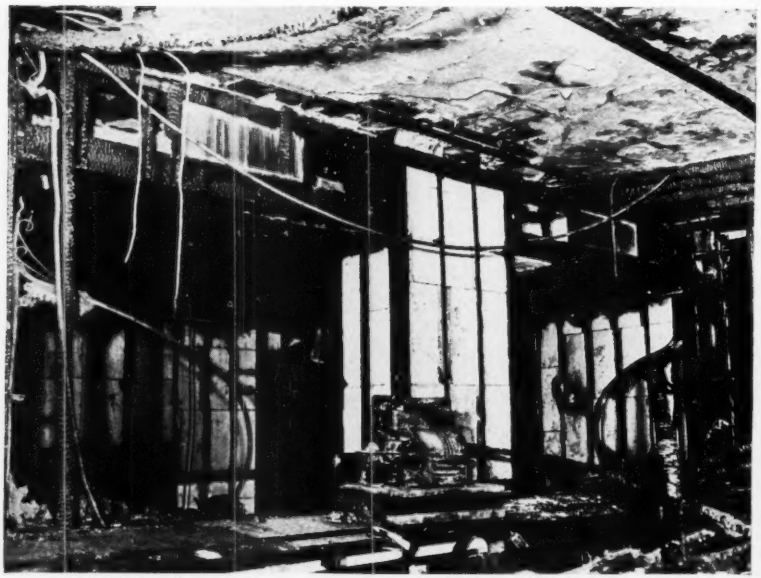
Combustible Fibreboards

By Robert S. Moulton

New building materials of many kinds have in recent years increasingly supplanted older conventional construction materials. Many of the new materials are noncombustible and their use tends to reduce the fire hazard, but combustible fibreboards have been responsible for a serious increase in fire hazard. Until recently, the fire protection fraternity has not appreciated the seriousness of this hazard, and neither building codes nor fire prevention regulations have taken the hazard of these materials into proper account. Building regulations, based upon time-honored construction methods using brick, wood and plaster interior finish, have generally failed to impose adequate controls on the use of combustible fibreboards, and the danger to life and property inherent in the use of a combustible interior finish with rapid flame spread characteristics has not been understood by the general public. Recent fires involving major loss of life have, however, now focused attention on this subject, and if the pattern of developments following major fires involving other hazards is repeated here, we may now expect the pendulum to swing to the opposite extreme of perhaps unnecessarily restrictive regulation of these inherently useful and economical building materials.

Fibreboards, commonly referred to as wallboards, insulation boards and by a variety of trade names, are made of wood fibre, cane fibre and other vegetable fibres, sometimes with the addition of binders to hold the fibres together. They are light in weight, relatively inexpensive and convenient to use, but their combustible fibrous surfaces are an invitation to the start and rapid spread of fire, and even where flaming combustion does not take place, those that are porous are subject to a burrowing or smoldering fire that may be difficult to extinguish. These materials have varying degrees of combustibility. The most serious feature as far as life hazard from fire is concerned is the rapid spread of flame along the surface of the board, which is characteristic of the majority of these materials. In the absence of some treatment to retard flame spread, many of these boards spread flame much more rapidly than ordinary wood surfaces.

The fibreboards discussed here should not be confused with boards made from noncombustible fibres such as asbestos or glass fibre, nor with noncombustible solid products such as gypsum board. However,



LaSalle Hotel, Chicago, Ill. June 5, 1946, 61 dead, 200 injured. Combustible fibreboard wall and ceiling finish in Silver Cocktail Lounge where fire originated.

it should be noted that a product using a combustible binder to hold together a non-combustible fibre may contain sufficient binder to make the board combustible.

The LaSalle Hotel fire, Chicago, June 5, 1946 (61 dead), the Canfield Hotel fire, Dubuque, Iowa, on June 9, 1946 (19 dead), and the Effingham, Illinois, hospital fire of April 4, 1949 (74 dead), are recent examples of fires where the use of combustible fibreboard has been an important contributing factor in loss of life. The accompanying photographs present other typical examples of the part these materials have played in fires.

Fibreboards alone are not responsible for fire; there must be some source of ignition and draft and other conditions favorable to the spread of fire. Thus, fibreboards should be considered primarily as a contributing factor aggravating the results of careless housekeeping, lack of control of potential sources of ignition, open stairways, excessive areas, lack of automatic sprinklers, lack of adequate exits and the like. Where other factors of hazard are obvious, the added hazard of combustible fibreboard may not always be noted by fire investigators, particularly where fire destruction is so complete that no remnants of the fibreboard remain in the ruins to tell their story.

Fibreboards are used for various purposes, and fall into different classes, depending upon their form and use, though the material itself may be the same. Insulation boards, so called, have thermal insulating properties and are so used, though their principal use is for interior finish, ceiling or sheathing, often in substitution for lath and plaster. Acoustical tile, with its characteristic holes in the surface, where made of combustible fibre, has the same surface burning characteristics as

wallboard made of similar material. Fibreboards are also used as plaster bases and for exterior sheathing. We are not here concerned with such uses as when the fibreboard is covered with plaster, or is covered with siding or shingles on building exteriors where flame spread on the surface is not a factor.

There are noncombustible or slow-burning materials available for all these uses, but unfortunately for the public, it is not easy in some cases to distinguish between combustible and noncombustible materials by appearances. To complicate the problem further, in some cases both are sold under the same trade name. Thus, acoustical tile on a ceiling, as viewed from below, looks very much alike whether it is made of a vegetable or mineral fibre, and where the trade name is the same it may be difficult for an ordinary inspector to tell the difference.

Flameproofing Treatments

Various flameproofing treatments are available which can be used to reduce the combustibility of fibreboards. The expense of a complete impregnation treatment with flameproofing chemicals may be so great as to make the cost of the treated product almost the same as that involved in the use of a noncombustible material and hence impracticable from an economic point of view. Surface treatments, however, may be useful in reducing the flame-spread characteristics of the surface which constitute the principal hazard to life safety involved in the use of these materials. The use of surface treatments is still to a large extent in the experimental stage and it may be expected that as a result of intensive research now being carried on by manufacturers of these products, fibreboards will be generally available with some flame-retarding surface treatment sufficiently effective to mitigate the hazard and permit the reasonably safe use of treated materials in many types of locations. There are various technical problems involved in flameproofing. The treatment must be such that it will not lose its effectiveness with age, will not promote smoldering combustion or the generation of noxious gases, and will not interfere with the appearance of the surface or the general utility of the product. Some of the flameproofing chemicals first tried for this purpose were subject to some of these objections, but manufacturers are making progress in developing surface treatments which can be applied in the process of manufacture of the materials at reasonable cost and providing reasonably satisfactory performance, although it should be noted that no surface treatment can make the mass of the material fire retardant and that there is opportunity for considerable difference of opinion as to the degree of effectiveness of the surface treatment and the extent to which materials so treated can properly be used.

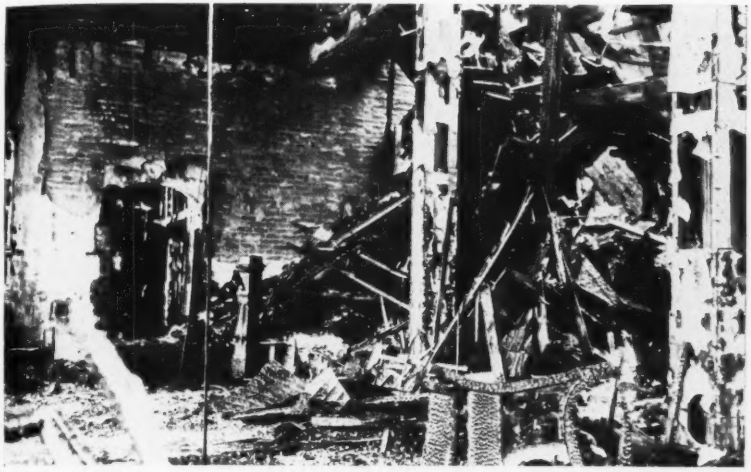
From the economic point of view, the treatment of acoustical tile presents much less of a problem than that of treatment of wallboard because of the higher unit cost of the acoustical tile and consequently smaller percentage increase in cost involved in treatment. Another factor to be considered is that acoustical tile is so made that only one surface is exposed, whereas some wallboards may have either or both surfaces exposed in the room so that where only one surface is treated there is no necessary assurance that this will be the surface which is exposed in the room.

Test Methods

The entire subject of combustibility of interior finish is under consideration by the Committee on Building Code Require-

Associated Press

St. Anthony Hospital, Effingham, Ill. April 4, 1949, 74 dead. Ceilings of corridors through which fire spread covered with combustible acoustical fibreboard.



Acme

Hotel Canfield, Dubuque, Iowa. June 9, 1946, 19 dead, 20 injured. Fire started in closet of fibreboard construction. Fibreboard in lounge and lobby.

Associated Press
St. Anthony Hospital, Effingham, Ill. April 4, 1949, 74 dead. Ceilings of corridors through which fire spread covered with combustible acoustical fibreboard.

ments for Fire Protection and Fire Resistance, a project sponsored jointly by the NFPA, the National Board of Fire Underwriters, and the National Bureau of Standards. Thus far nothing in the way of an official standard has been developed. An important handicap in the development of standards is the lack of general agreement as to tests to be used for evaluating the combustibility of various products. Underwriters' Laboratories has developed a tunnel test for determination of surface combustibility. This was described in an article in the July 1943 *Quarterly* (Vol. 37, No. 1, page 69), and is summarized in the Tenth Edition of the NFPA *Handbook of Fire Protection.* While the merits of this test method are generally recognized, manufacturers of fibreboards have felt handicapped by the lack of a recognized small scale test which they could use for evaluation of the merits of different products and treatments in the course of their development work.

There are also well-recognized tests for classifying the burning characteristics of acoustical materials developed by the National Bureau of Standards and published in Federal Specification SS-A-118a. These tests, based on recognized time-temperature curves, are such that materials classed thereby as "incombustible," "fire retardant" or "slow burning" appear to merit these designations.

A commercial standard soon to be issued by the U. S. Department of Commerce will include a classification of "flame-resistant finished surface treated" fibreboard. This classification is based on an industry developed small scale test with a sample exposed to a relatively small flame of short duration. This test was devised for use by manufacturers in the evaluation and production control of their products and is not offered as a use test or for building code purposes.

Extensive research is now in progress on this entire subject of test methods.

Press Association

Balantyne's Store, Christchurch, N. Z. Dec. 10, 1947, 41 dead, 3 injured. Extensive use of combustible fibreboard for interior wall covering and partitions.

Assuming that the present research is carried to a conclusion, we may reasonably anticipate clarification of this entire subject, suitable correlation between large and small scale test methods, and also correlation between room size tests and laboratory tests. In many phases of fire testing, the behavior of materials is found to be very different when tested on a large scale from the results where tested on a laboratory scale; it still remains to be determined what the effect of the scale of tests will be in the case of fire testing of fibreboards. The experience in fires shows that with combustible materials in general, fires burn relatively slowly at the start. As the heat in the entire room is built up, eventually the temperature reaches a point of flash-over where all combustible surfaces flash into flame. The differences in flash-over characteristics between fibreboard surfaces and ordinary wood surfaces have yet to be determined. However, such actual fire experience data as are available would indicate that at least in the case of some combustible fibreboard products, flash-over occurs in a shorter time or at a lower temperature than in the case of wood.

Method of Application

The method of application of the material manifestly has an effect on the fire hazard. Where acoustical tile, for example, is cemented directly to a plastered surface with no intervening space, there is no opportunity for development of spread of fire behind the surface as is the case where fibreboards are fastened to nailing strips or nailed to wood joists with an open space behind. Wherever the combustible fibrous material is so installed as to have an open space behind it, there is a possibility of spread of fire through this space just as in the case of exposed wood lath on the inside of hollow walls in the older conventional forms of construction. While such open spaces are a hazard, this appears to be nothing new or different from that which we have known for many years and may be controlled to a reasonable degree by suitable firestopping or filling the spaces with noncombustible material

Milwaukee Journal

Ladish Company Metallurgical Laboratory, Cudahy, Wisc. June 13, 1948. Loss $504,500. Combustible fibreboard drop ceiling and interior wall finish.

Balantyne's Store, Christchurch, N. Z. Dec. 10, 1947. 41 dead, 3 injured. Extensive use of combustible fibreboard for interior wall covering and partitions.

Armory Annex, Portland, Me., February 24, 1945. 1 fireman killed, 2 injured. Loss $250,000 and Army records. Walls and ceilings sheathed with combustible fibreboard; numerous combustible fibreboard partitions.

Armory Annex, Portland, Me. February 24, 1945. 1 fireman killed, 2 injured. Loss $250,000 and Army records. Walls and ceilings sheathed with combustible fibreboard; numerous combustible fibreboard partitions.

Knights of Columbus, Hostel, St. John's, Newfoundland. Dec. 12, 1942, 99 dead, 109 injured. Entire interior walls and partitions finished with combustible fibreboard.

such as mineral wool or other noncombustible insulating materials. The main factor of life safety from fire is the spread of fire on the exposed surface of the material and it is debatable whether this is affected to any great extent by the presence or absence of an open space behind the surface. However, if the method of fastening the material is such that it will be readily loosened from the surface and fall to the floor when exposed to a moderate degree of heat in the early stages of a fire, this manifestly increases the hazard.

Use of Fibreboards

It may be some time before full agreement is reached on test methods and the proper regulation of the use of combustible fibreboard materials. Pending the reaching of some agreements and committee action looking towards the adoption of official NFPA standards, the user may continue the unrestricted use of fibreboards in the absence of any legal prohibition, or he may decline to use combustible fibreboards at all because of the fear of fire. Either extreme should be avoided. Just what the intermediate position should be is still a matter of speculation. The writer believes that the eventual solution of the problem may be somewhat along the following lines:

No fibreboard of extreme combustibility should be used in any building unless the surfaces are covered or coated in some way to reduce the hazard to an acceptable degree. The upper limit of surface combustibility permitted might be taken as that of the most combustible forms of ordinary wooden surfaces ordinarily exposed to fire on the interior of buildings.

Exposed interior finish materials should have completely noncombustible surfaces in all large buildings where there is a major danger of loss of life by fire, including theatres, assembly halls, hotels, hospitals, schools, night clubs, bowling alleys and other recreation buildings where used as places of assembly, and the like. The prohibition of the use of any form of com-

Citrus Concentrates plant, Dunedin, Florida, August 27, 1945. Loss $2,200,000. Ceiling and built-up wooden trusses sheathed with fibreboard. Fire within hollow finish of truss communicated to nonfirestopped joist channels.

Acme

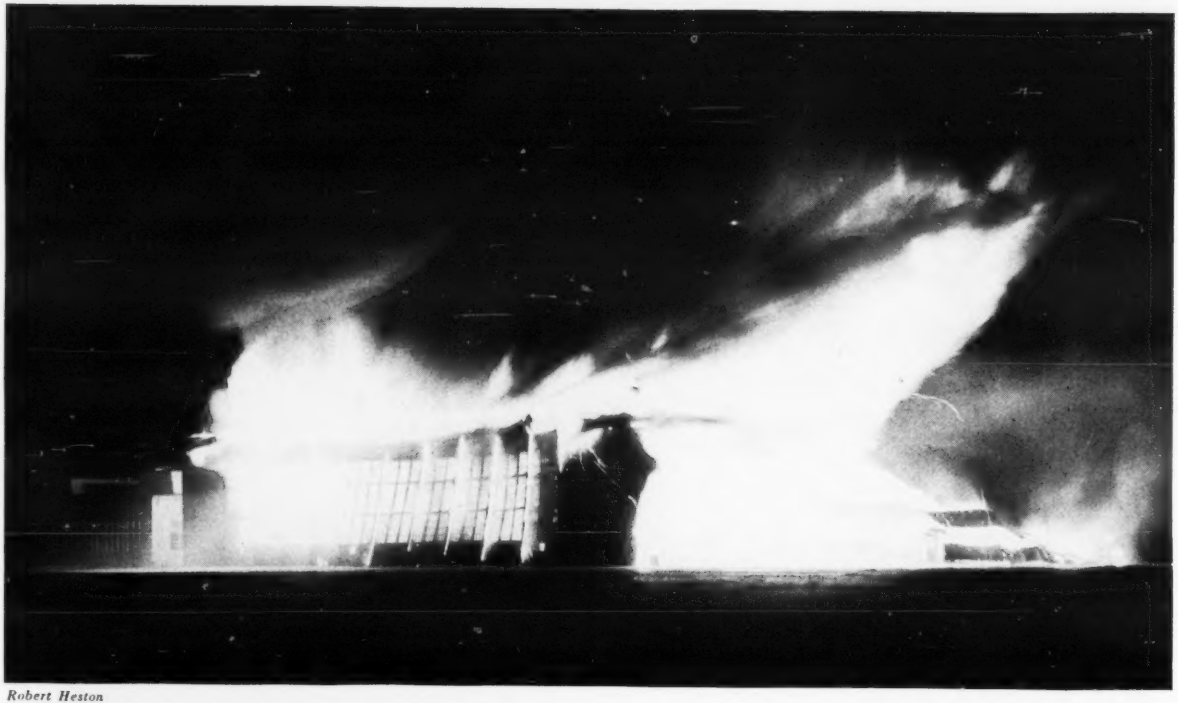
Recreation Center and supermarket, Providence, R. I. Nov. 13, 1947, $400,000. Ceiling and upper half of walls in bowling alley of combustible fibreboard.

bustible interior finish materials in such occupancies should apply to large open areas or corridors which might be the means of spread of fire and need not necessarily apply to individual small rooms so separated from the balance of the building that spread of fire along the surface is not likely to occur. There may be opportunity for considerable difference of opinion as to the area limits to be specified in such cases.

In mercantile buildings, factories, apartment houses and various other occupancies, there is a field for the use of a surface-treated product intermediate in combustibility between the untreated fibreboards and the noncombustible materials. It may in fact be appropriate to recognize several grades of products with various degrees of combustibility with appropriate differentiations between maximum surface areas permitted for each and the types of occupancies in which they are to be used. The present danger here lies in the possibility of recognizing for such use types of surface treatments which do not have sufficient value for the purpose intended or, on the other hand, to make requirements for flameproofing so restrictive as in effect to bar the use of the material.

Wherever a standard automatic sprinkler system is properly installed and maintained to protect the surface, the requirements for combustibility can presumably be relaxed, although even with sprinklers there should be some limits of combustibility, for there is at least a strong suspicion that with some of the most highly combustible fibreboard products, under certain conditions of draft, the spread of flame along the surface of a ceiling may be faster than the rate of opening of ordinary types of automatic sprinklers. The extent to which requirements might be relaxed where sprinklers are installed may be another subject involving differences of opinion ranging all the way from the view that automatic sprinklers so increase the safety that no requirements at all are needed, to the other extreme that it is always possible that someone may shut off the water supply to the sprinklers and that therefore the requirements for interior finish should be just the same

within hollow finish of truss communicated to nonfirestopped joist channels.



Robert Heston

Old Amarillo Army Air Field Hangar, near Amarillo, Texas. Sept. 9, 1948. Loss $320,000. Interior wall and ceiling finish of the 299 ft. long structure two thicknesses of ½-in. combustible fibreboard.

whether or not automatic sprinklers are installed.

While we may look forward with some optimism to the eventual solution of the major problems involved in the case of future production and installation of these materials, we still are confronted with the very serious problem of millions of square feet of fibreboards of a high degree of combustibility found in existing buildings of all types. The experience in recent fires shows that it is absolutely essential in the interest of public safety to take some measures to mitigate this hazard, particularly in hospitals, hotels and places of assembly. Short of replacing the material, the only practical measure is to install automatic sprinklers or provide some flame-retardant surface coating. Fortunately there are flame-retardant paints available which are reasonably effective for this purpose, although they may involve considerable trouble and expense in application and may have to be renewed at intervals to maintain their effectiveness. Any paint applied to a fuzzy, fibrous surface tends somewhat to reduce the surface combustibility. A suitable flame-retardant paint is, of course, to be preferred. Fortunately fibreboard materials can in general be painted or coated satisfactorily without interfering with their use value or appearance. Question is often raised as to whether the exposed surface of acoustical tile can be painted without affecting its sound-deadening value. While a paint or coating may have some effect, the best information that we have been able to secure is that so long as the perforations in the material are not clogged the surface painting should not have any very serious effect upon the sound-deadening qualities of the material.

Fire Commissioner, Saskatchewan

Municipal Street Railway Car House, Regina, Saskatchewan. Jan. 23, 1949. Loss $1,117,000. Suspended ceiling of combustible fibreboard.

structure two thicknesses of 1/2-in. combustible fibreboard.

Arson Prevention

By R. K. Goeriz

Detective Inspector, Detroit Arson Squad

Arson prevention is not a new idea. In a broad sense, it has been practiced since early English Common Law made arson a capital offense. Changing social, political and economic conditions have influenced arson prevention techniques, but the fundamentals are based on age-old principles. Felonious fires often involve loss of life or personal injury to innocent victims as well as resulting in property destruction. The importance of arson prevention is thus as vital as other crime prevention work for the well-being of society.

As in all phases of law enforcement the greatest deterrent to arson is the fair, persistent and uncompromising enforcement of the legal statutes available. In other words, the greatest preventive force which an arson prevention agency possesses is its own public reputation for efficiency. Arson prevention can be effective only if it is common community knowledge that violations of arson statutes will probably lead to very serious consequences for the perpetrator. Persons don't readily commit offenses when they know that there is a good chance of being caught, and it is just as true that poor law enforcement is an invitation to further crime.

It is not safe to assume, however, that all motives responsible for arson fires will respond to the same treatment. Obviously, the effectiveness of arson prevention programs must recognize the various types of motives behind the arsonists' acts. Generally, those persons who are likely to set fires for financial gain can be most readily restrained and, year in and year out, they are the ones that cause the greatest number of arson fires.

Arson is one of the more difficult crimes to cope with and presents problems which few other criminal investigators must face. It is not surprising, therefore, that fire marshals often convince themselves that in arson control they face almost insurmountable odds single-handed. This is particularly true if they visualize the effectiveness of an arson control effort only in terms of convictions or persons sent to prison. Convictions are, of course, a sure yardstick of progress where circumstances provide sufficient proof for such legal action. There are, however, a number of other measures which can prove to be nearly as effective where the evidence is not fully definitive. In fraud fires particularly, if it is impossible to obtain a conviction, the next best thing is to take the profit out of the fire, i.e., to use every legitimate means to see that the insured does not profit from his criminal actions.

It is just as important, of course, that those persons who have legitimate losses are protected to the fullest extent. It is as much the responsibility of law enforcement officers to protect those who may be unjustly accused or suspected as it is to punish those who are guilty. However, when the word is passed around that it is difficult if not impossible to make any money by a questionable fire, we then have a strong deterrent at work to stop arson crimes. The first, and most impor-

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This article is based on a talk presented at the 53rd Annual Meeting of the National Fire Protection Association at San Francisco, May 16-19, 1949.

tant step in this direction is a thorough understanding with the agents and adjusters representing the insurance companies that no loss be settled while any case is under investigation without the knowledge and consent of the investigating officers. Our experience along this line has always been most satisfactory. Contrary to public opinion, our only criticism is that in many cases insurance companies have been too liberal in their adjustments.

One of the greatest deterrents against any crime is an aroused public opinion. It is no accident that whenever a public official embezzles public funds, a great hue and cry arises; even the statutes provide more severe penalties for this type of embezzlement than for a like private crime. It is obvious that this results from the more violent reaction of the citizenry when part of the money embezzled is his own hard-earned cash which was taken from him by the tax collector. It then becomes a personal thing rather than an abstraction and John Doe, citizen, is justly indignant. Too many persons view a fire loss, legitimate or otherwise, as a private affair between a big insurance company and a poor individual. In many cases public sympathy is misplaced in the individual. This is reflected in courts, juries, prosecuting officials and public sentiment, and thereby handicaps arson prevention work.

There are few persons who own property of any kind who can afford to be without fire insurance. This is important, as it has a long range effect on arson prevention activities. I feel, however, that the public generally are not well informed as to the functions and operations of fire insurance companies. Very few people recognize the fact that fire insurance companies act as agents, collecting premiums from many individuals and passing the funds along to those who suffer fire losses, retaining, for their services, what amounts to a fee which is regulated by public legal statutes. This may be somewhat of an oversimplification, but when every policyholder is made to recognize that part of his money goes to pay many fire losses, the whole business can become very personal to him and he should feel as strongly about incendiary and even preventable fires as he does about misuse of public funds. If we can ever educate the public to this type of thinking, our job will be two-thirds done.

While the above points out a desirable long range program, there are many specific plans which can have immediate effect. One of the most effective deterrents is to remove temptation whenever it becomes apparent. This, of course, requires a working arrangement with the insurance company representatives in your area who have as great or greater interest in preventing fires in properties which they cover as you have.

First, you must know your City, State or Province. I must talk on the basis of my experience which is in a major metropolitan area. By studying population concentrations of racial or nationality groups, the condition and age of buildings, the types of business and occupancies, economic conditions, etc., you can determine that arson will be found much more frequently in some sections than others. It is then possible to apply a system of selective enforcement by exerting the greatest pressure wherever there is the strongest probability of incendiary fires.

As a matter of practice, I doubt whether any alert marshal or arson investigator would find it necessary to go back into his records to select these areas. He knows

from experience where most of the danger spots are. For example, in my city I have been able to show insurance company representatives that there is a direct relationship between the fire frequency in certain areas of my city and major crime, juvenile delinquency, welfare loads and substandard housing. As a result, these insurance underwriters have pretty largely decided not to write any more business in these areas. This has proved to be no hardship on the occupants since they were of a class who carry little or no contents insurance, and the building owners had received many times their original investments through "milking" the properties.

Several years ago we had a serious problem when all buildings for a number of miles on one side of a main artery were being condemned in connection with a highway program. When condemnation plans were announced, several fraud fires occurred. At the suggestion of the head of the arson squad, a flat percentage reduction in insurance was made on all affected occupancies, largely retail merchants, and as time progressed, further reductions were made. Needless to say, these measures stopped the "set fires," as the possibility of profit was removed. At the present time, another of these areas in my city is in process of being condemned for a public housing project. This does not possess the same temptation in the mind of the arsonist so we are not experiencing trouble with this project. The profit motive does not exist there. We have another street in our city where it is a general practice to write coverage to no more than 50 per cent of actual value. This resulted from years of sad experience. After that policy became effective, fraud losses stopped.

The same principle applied in another manner can be even more effective. As you all know, certain occupancies or kinds of business will be much more subject to temptation than others, depending on the economic situation, time of year, prices on harvested crops, and many other factors. You have only to pick up your daily paper and read the ads to see where your greatest prospect for trouble lies. A close working arrangement with the various credit reporting agencies is of utmost value here. On many occasions we have received such information as: "The business is in bad shape generally, inventories very high" or "our records indicate that Blank Co. is overstocked with obsolete or seasonable merchandise and very much overinsured" or "John Doe, who had a bad fire and bankruptcy record in New York or California, just bought a controlling interest in the XYZ store." Similar information can come to the marshal through a variety of sources. If the acquaintance of the credit companies and similar sources is cultivated, such information will soon come to you voluntarily and as a matter of routine.

Information of this type should be all the marshal or arson squad needs to go to work. The first job is to determine which fire insurance companies have the risk and check with the company representative to acquaint him with the facts. Secondly, make sure that the assured knows that you know the situation. Here is where the fire inspection division can become a valuable force in arson prevention. Whenever such a situation comes to our attention, it is my practice to request the Fire Marshal to set up a special inspection procedure. If the situation appears to be critical, this may involve weekly or even daily inspections by uniformed fire inspectors, and the inspector may be directed to take extensive notes and even a quick inventory. It doesn't take long for persons with arson

on their minds to get the idea.

For example, we received information from a reporting agency that Mr. Blank had recently bought control of an old established firm which was almost inoperative from lack of materials, although they owned a number of very large buildings in a congested area. This individual had previously owned properties in which a number of incendiary or suspicious fires had occurred and also had a record of bankruptcy. A check showed that the purchase price was $60,000 and the insurance in force on buildings, contents and business interruption was about $360,000. Shortly after the purchase, a loan of $50,000 was made by a governmental agency, leaving Mr. Blank with only a $10,000 cash outlay. The business continued to lose money because expected supplies were not forthcoming, yet the $360,000 worth of insurance remained in force. All that was needed was a match.

The insurance company agent was contacted and he immediately sent notice of cancellation. The assured, however, is allowed five days of grace by law before such cancellation can become effective. An inspection made under the direction of the Fire Marshal disclosed little stock on hand, poor housekeeping and also the fact that about the first activity of the new owners was to start to dismantle and make inoperative a sprinkler system installed in the property. The Marshal stopped the dismantling but found it necessary to take the assured into court to force them to put the sprinklers back in service. During the five-day cancellation period, we provided the occupants with lots of police service; in fact we gave them a radio scout car which did nothing but patrol the premises for 24 hours each day. About six weeks later, another company agent called and said that he had taken a binder on this same risk without having any of the above described information and had been notified by his company that on clearing through the National Board of Fire Underwriters a bad risk was indicated. On being told the story, he asked: "Will you do as much for me as you did for the other fellow?" We also gave him the same police protection while his five days ran out. Shortly thereafter our friends disposed of the property. We have no way of knowing in this case whether or not the owners had any thought of a fire; however, we did our best to see that they weren't tempted.

This illustrates one of the weaknesses of the fire insurance business. With a large number of company agents working independently and in competition with each other in any given area, it appears that insurance can be secured on any property, no matter how bad a risk it is, with one or another insurance agent and will be effective until canceled by the home office after checking with the National Board or other protective organization. The sheer magnitude of the business introduces a time element which can be costly. Perhaps thought should be given to some means of clearance of questionable cases at the state or local level.

There are other types of fires not involving fraud which will respond to active preventive measures. One of these is the use of fire in racial or minority group conflicts. These can become most serious if allowed to get out of hand. Whenever we have a fire or threat of fire involving racial or labor difficulties, we throw all available manpower into the investigation. The most effective measure in these cases is to place the burden directly on the leaders of the various factions. This is best accomplished by making it clear that you look to them to prevent any threatened action or recurrences. As a practical matter

you know before you start that the possibility of convicting guilty parties in cases of this sort is very remote, the reason being that nearly all persons who could serve as witnesses either have guilty knowledge or strong sympathies and it is improbable that they will cooperate. This is no reason to give up, but rather it is the time you should apply all possible pressure. If you have semi-judicial powers, hold public hearings and bring all parties in for statements. If you have no such power, your prosecuting officials do, and they can perform the same function. Make it clear, short of libel, that you hold the leaders responsible and use news releases as a means of bringing the situation to the attention of the public.

Another effective deterrent is the general knowledge that all fires except the most minor ones will be investigated. Many fire marshals have critical problems, particularly as to manpower, but the job cannot be done effectively until fire investigation extends beyond merely those fires which are thought to be suspicious by the fire fighting officers. With all due respect to them, they do not have the training or experience to enable them to arrive at accurate conclusions in all cases. About 90 per cent of the fires that occur are obviously of no interest to the arson investigator. The remaining 10 per cent will cover about 80 per cent of the loss and will include all fires which could possibly be of interest to the arson investigators. We cannot describe here the methods used in selecting the fires to be investigated, since the problem will vary in different parts of the country; however, it is no particular problem if approached intelligently.

The value of investigating as many fires as possible is twofold; first your men get wide experience in investigating all kinds of fires and, secondly, the public is thereby made conscious of the presence and activities of your investigators and this acts as a powerful deterrent to acts of arson — something like seeing a motorcycle officer in your rear-view mirror.

Fires are news and the resulting publicity may be used to good advantage if you do an intelligent job in your press relations. Here we must differentiate between personal publicity and organization publicity. The first will naturally follow your activities and may satisfy the ego, but it is also a two-edged sword which cuts both ways. The latter is most important as a deterrent. It is essential that the public knows that your agency is on the job and functioning. Publicize the efficiency of the organization rather than the individual. Just a few lines in every fire story to the effect that the Fire Marshal or the Arson Squad has the cause of the fire under investigation has a tremendous moral effect.

Your effectiveness in the arson prevention field is limited only by your ingenuity and the amount of honest, conscientious effort that you put into it.

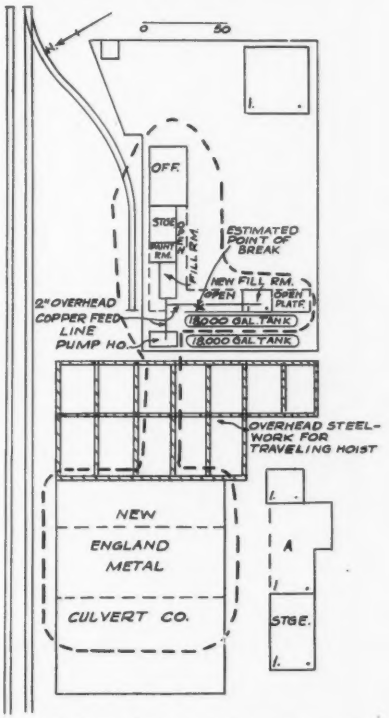
Bottled Gas Fire, Palmer, Mass.

On August 10, a break occurred in a 2-inch copper pipe carrying liquefied propane under 250 lbs. per sq. in. pressure at the Home Gas Corp., Palmer, Mass. The ensuing fire destroyed the propane bottling plant and severely damaged the building and equipment of the New England Metal Culvert Co. on adjacent property. Certain features of the Home Gas Corp. installation not in accordance with NFPA Standards on Liquefied Petroleum Gases (No. 58) have been reported as responsible for the start of the fire and the extensive damage. Summarized briefly they are:

1. Failure to maintain a minimum of ten feet space between the aboveground storage tanks and bottling plant.
2. Installation of the aboveground storage tanks within 50 feet of the adjoining property line.
3. Use of ordinary sweated solder joints on copper pipe.
4. Use of a combustible building for a bottling plant.

This plant was located in an industrial district about one mile from the business center of Palmer. The area was not heavily built up and contained no dwellings. Formerly operated by the Texas Co. as a bulk oil plant, the property was acquired in 1941 by the Home Gas Corp. for the filling and maintenance of propane cylinders, storage of household appliances, garages and office space. The principal building, a 1-story wood-frame, metalclad structure 20 ft. wide and 85 ft. long, had been subdivided into a cylinder fill room, cylinder paint room, storage section and small office. (See diagram.)

Two aboveground 18,000 gal. (ASME U-69) storage tanks had been installed



Bottled gas plant fire, Palmer, Mass., Aug. 10, 1949.

parallel to each other on concrete saddles along the boundary of the adjoining New England Metal Culvert Co. This installation was therefore not in accordance with provision B.5(a) of the NFPA Standards for Liquefied Petroleum Gases which specifies that no aboveground tank of over 1,200 gallons capacity shall be installed nearer than 50 feet to important buildings or to the line of adjoining property that may be built upon (although a clear space of 60 feet had existed between the property line and the nearest building of the New England Metal Culvert Co. when the

Wide World

Operation of safety valves on two 18,000 gal. aboveground propane storage tanks prevented their explosion during fire at a propane bottling plant at Palmer, Mass. The 100-ft.-high column of flame in the picture was fed by gas escaping from tank safety valves.

tanks were installed in 1941). Originally, the tanks met provision B.5 (b) namely, that no tank exceeding 500 gallons capacity shall be located closer than ten feet to a gas distributing building, but a recent addition to the building (loading dock and second fill room) extended along one side and within a foot of the tanks. Involvement of this tank and spread of fire to neighboring property were due to the severe exposing effect of fire in the adjacent combustible addition.

Piping for the transfer of liquefied propane between tank cars, pumps, storage tanks, and fill rooms consisted of an overhead system of 2-inch copper pipe apparently installed in accordance with NFPA Standards except for the use of

sweated solder joints using ordinary low-melting point solder instead of screwed, flanged, welded joints, or joints made with solder having a melting point over 1000°F as required by section B.7(c) of the Standards. The original break in the tubing occurred at a sweated joint.

Other buildings at the Gas Company plant were a 1-story concrete block pump house and a well-detached garage. Electrical equipment in all areas with the exception of fixtures in the office and garage was suitable for Class I, Group D locations.

Four men were in the plant on the afternoon of August 10, one in the fill room, one in the paint room and two in the office. At 4:00 P.M., the men in the office, on hearing escaping gas, investigated and saw what appeared to be a break at a joint in the 2-inch overhead line carrying propane from the pump house to the new fill room adjacent to the storage tanks. The valve at the pump house was immediately closed and the two men were observing the cloud of vapor around the tanks when a flash occurred that severely burned them both. The original igniting source, although unknown, may have been a static spark generated by vapor escaping under 250 lbs. per sq. in. through the broken joint.

Vapors that accumulated during the 1½ minutes required to close the valve, plus the liquid in the 80 feet of pipe from the pump to the break, were sufficient to ignite the combustible bottling building and the new addition. The following events then took place in rapid succession. Spring loaded relief valves operated on several of the filled cylinders in the building, adding more fuel to the fire. (Of the 150 in the building only one skyrocketed, although several empties ruptured.) Heat from the burning structure caused sweated joints to loosen on top of the adjacent storage tank. Relief valves on the storage tanks operated, and when gaskets under manhole covers burned out more vapor escaped and burned.

The fire department had been summoned without delay by telephone and street box, but found both the bottling plant and the 1-story concrete block building of the New England Metal Culvert Co. afire. Flames were coming from vent pipes, from loosened pipe joints and from around manholes of storage tanks. Heat was so intense that the bottling plant could not be approached with hand lines. A deluge stream was set up and directed at the building, by then obviously lost. Firemen concentrated on extinguishing fire in exposed property which was brought under control in an hour's time. Fire at the bottling plant had by then subsided sufficiently to allow use of hand lines on the building and a fog nozzle deluge gun on the tanks. Vapors continued to burn at the tank vents until the contents were completely consumed 8½ hours later.

Damage to the building and overhead steel work at the New England Metal Culvert Co. was severe (estimated $70,000). The main building of the bottling company was completely destroyed and one of the two storage tanks will have to be replaced. This tank, although properly protected by relief valves, developed a bulge believed caused by impingement of burning vapors escaping from one of the loosened pipe joints. Loss to Home Gas Corp. property is estimated at $40,000.

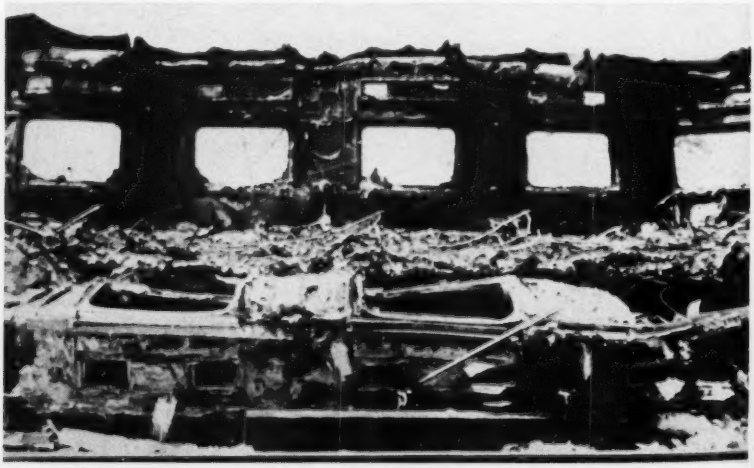
Propane Fire on Railroad Train

The "City of Los Angeles" was speeding through the Mojave Desert on the night of July 7, 1949, when fire broke out in the air conditioning equipment of the Pullman car "Wilshire." Upon discovery at 9:15 P.M., the passengers were vacated and the train immediately stopped at mile post 191.0 near the small wayside station of Afton, California. This location, remote from public fire protection services, prevented taking effective fire fighting action and there was no choice other than to disconnect the burning cars from the rest of the train and to allow the fire to burn itself out.

The results of investigations indicate that the fire was due to a combination of circumstances starting with the disconnection of the generator link to the carburetor of a Waukesha, propane-fired engine. This permitted the engine to overspeed and, in turn, to overheat the exhaust manifold. There is evidence to support the assumption that a large section of the check damper located at the discharge end of the exhaust muffler had been knocked out and that hot exhaust gases impinged directly on heater pads which warm the propane storage tanks during cold weather. The excessive temperatures developed in the heater pads eventually caused internal pressure to build up within the propane tanks sufficient to open at least one relief valve, releasing propane.

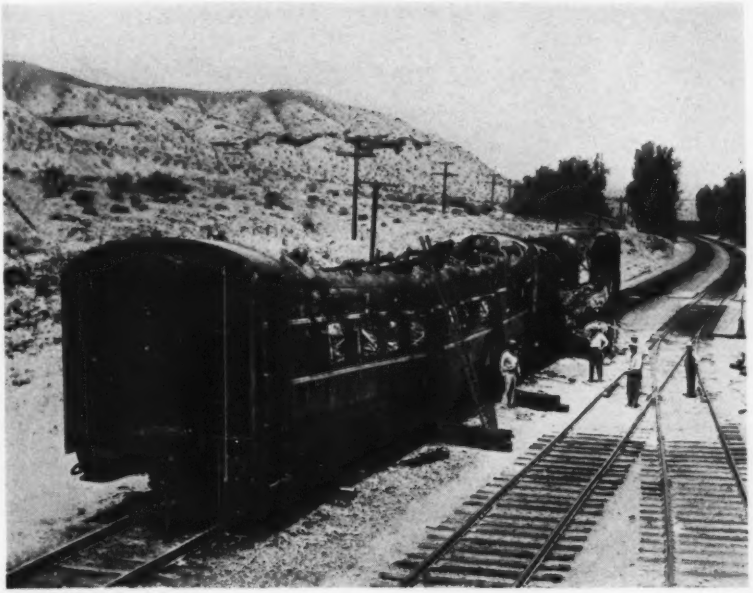
The propane storage tank cabinet housed three ICC-4B-240 cylinders and was located less than five feet to the rear of the articulated truck on the Pullman car "Wilshire." It is a logical conclusion that sparks produced as the brakes were applied furnished the ignition source.

This unusual accident has been reported to the NFPA by Mr. J. M. Bates, General Fire and Safety Engineer of the Union Pacific Railroad (NFPA member).—Ed.



Union Pacific Railroad Co.

The propane fire originating in the air-conditioning unit developed such heat intensity that hard-drawn aluminum structural members and the aluminum body of the Pullman car were melted.



Union Pacific Railroad Co.

The fire originated in the forward of these two "articulated" Pullman cars as the "City of Los Angeles" approached the desert way-station of Afton, California.

This liquefied petroleum gas fire produced such high heats that it melted down hard-drawn aluminum structural members used in the car construction. The extent of the damage is indicated in the photographs. Attempts to suppress the fire with portable dry chemical and carbon dioxide fire extinguishers were futile.

Two Pullmans were a total loss, since they formed one unit (railroad parlance: "articulated cars") and the fire propagated from the car of origin to the adjoining unit. Twenty-five persons were evacuated from the affected units without injury by alert train personnel and, according to newspaper reports, one 10-year-old boy asleep in one of the cars was heroically rescued by a train crew member. An attempt was made to halt the train opposite a small water tank and pump house on the railroad right-of-way with the thought of thus having available a fire hose at that location. Due to the excessive smoke, however, it was not possible to pass signals to the engine crew and when the stop was made the burning car was on a wood bridge about 500 ft. from the water tank hose line. In view of the fire exposure to the bridge (the bridge was ignited but the fire was later extinguished), there was no choice other than to pull the two cars clear of the bridge and separate them from the rest of the train.

Yermo, California, located 28.3 railroad miles distant, sent a volunteer fire company to the scene, but the time consumed in response over unimproved roads prevented their being effective. The fire loss to the Pullman equipment is estimated at $200,000. Some additional loss of passenger's personal effects is expected.

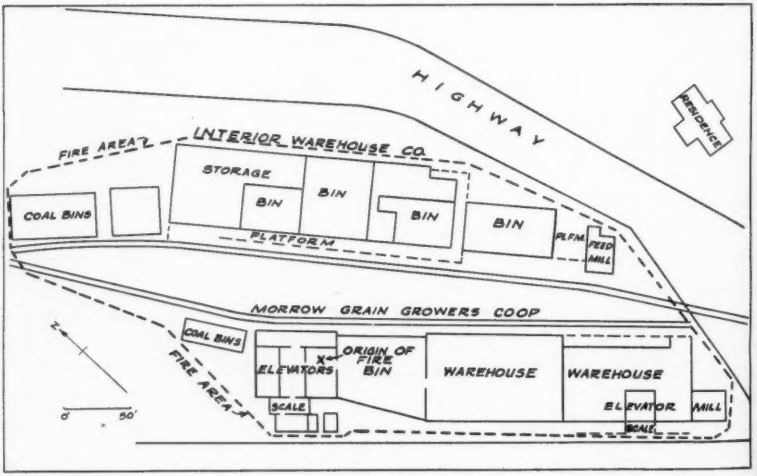
Grain Elevator Fire, Heppner, Oregon

Shortly after 5:00 P.M., July 18, 1949, fire broke out in the head house of a 75-foot high elevator operated by the Morrow County Grain Growers Cooperative Association, Heppner, Oregon. Four hours later, three elevators, the office, bins and warehouse sections of this grain storage and processing plant, the bins, office and warehouse of the neighboring Interior Warehouse Co., two coal yards and eight box cars lay in ruins. This fire is another example of the long recognized fact that fires in head houses, because of their inaccessibility, the combustible construction of elevators and their vertical openings, present an almost insurmountable problem as far as public fire protection is concerned. This is especially true in small communities where it is not economically feasible to maintain public fire protection sufficient to cope with such situations. Nevertheless, operators of a relatively insignificant number of elevators have acted to provide additional protection for their property, such as an automatic detection system, and where adequate water supplies exist, an automatic sprinkler system both in the head houses and lower levels. It is a reasonable supposition that such protection would have prevented this $400,000 loss at Heppner.

Reference to the accompanying diagram will show the size and relative position of the buildings in the fire area. Notable features are the combustible construction, congestion and lack of fire walls.

Private protection in both plants was limited to first aid equipment. Public protection consisted of ten active volunteers, ten reserves and one piece of apparatus — a Bean High Pressure unit mounted on a 1939 Chevrolet chassis, carrying 350 gallons of water, two booster reels, 1000 feet of 2½-inch and 100 feet

Based upon report submitted by the Oregon State Fire Marshal.



Fire Marshal, Oregon

Lack of automatic means of detection and extinguishment of fire in the head house atop the elevator at left was responsible for this disastrous fire in Heppner, Oregon.

of 1½-inch hose. Water was available from a creek that passed within 300 feet of the elevator group, and a 4- and 6-inch looped main supplied through an 8-inch main by a 1,100,000-gallon reservoir. Hydrant pressure, normally 80 p.s.i. on the loop, had been seriously reduced by a break that occurred in the 6-inch main in February. As an emergency measure the damaged section had been gated off (and apparently forgotten) thereby converting the hydrant supply to a long dead end 4-inch main.

The Fire

Both plants were busily engaged in receiving wheat from adjacent ranches and loading out freight cars on July 18. Shortly after 5:00 P.M., the manager of the Interior Warehouse Co. noticed smoke coming from the head house of the neighboring Growers Cooperative and after directing his men to give the alarm and start moving freight cars, he hurried over to warn the Growers Cooperative foreman. Thirty minutes earlier, the foreman had found all in order on routine investigation of motors, bearing and belts, but was now prevented from reaching the head house via the man lift by flames working down through the shaft. Records were hastily removed from the office as a 15-20 mile wind swept fire rapidly through the combustible bins and warehouse sections. Eye witnesses state that within twelve minutes of the alarm, the Growers Cooperative was beyond saving and the head house had crashed down, igniting box cars and the Interior Warehouse buildings.

Because of the threat to the entire community caused by the wind-carried shower of flaming debris, fire fighting was concentrated primarily on protecting exposures and extinguishing spot fires. Upon receipt of the alarm at 5:08 P.M., Heppner firemen stretched a line to the fire from the nearest hydrant. When this proved futile

due to low water pressure, the line was transferred to a more distant hydrant not on the dead end main. The Bean unit was driven between the two plants in an attempt to prevent involvement of the Interior Warehouse Co., but was forced to withdraw when the Growers Cooperative head house toppled. From then on this unit roved on the fringe, checking spot fires and cooling down exposures, including several dwellings and the nearby bulk oil plant of the Union Oil Company. Citizens armed with shovels and garden hose, and six mutual aid companies responding from towns up to 61 miles distant assisted in this work and it is a credit to this combined effort that with the exception of a barn or hay stack here and there, the town was saved. The fire at the two grain plants began to subside after the first hour, but was not finally out until 2:00 P.M. July 19.

Fire Doors Save School

These swinging fire doors (removed from their mounting after the fire) in the Lynn, Mass., high school between the auditorium and the classroom section, according to the Lynn Fire Department, were a major factor in saving the balance of the school when the auditorium section burned on Sept. 14, with a loss estimated at $250,000.

San Francisco Grocery Warehouse Fire

There are certain essential features of a fire protection program for a combustible storage warehouse. If any of these is omitted (e.g. sprinklers) or if minimum standards for any one feature are compromised (e.g. standards for protection of openings), the results are liable to be disastrous. The fire at the San Francisco grocery warehouse of Safeway Stores, Inc., August 30, is a forceful example of what may be expected from a substandard and incomplete fire protection program.

Construction and Protection

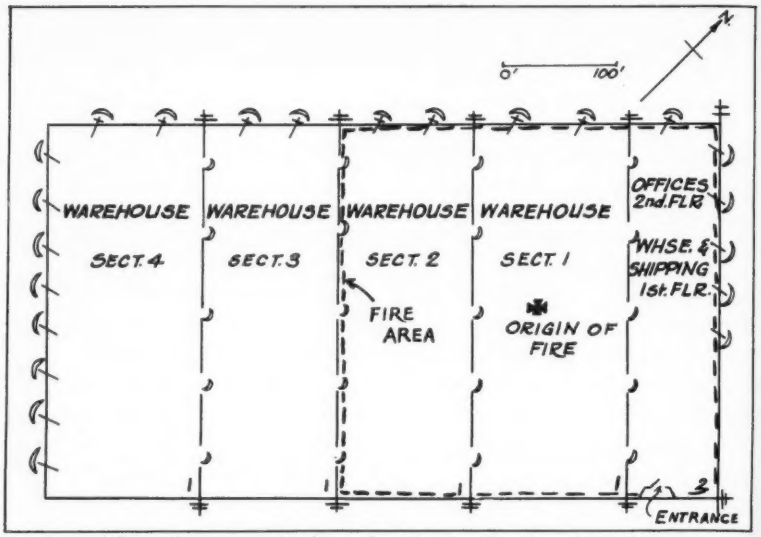
Walls of the 600 ft. by 330 ft. building, mostly one-story (see diagram), were brick; the flat roof was tar and gravel on wood sheathing supported by exterior walls and by heavy wood beams. Wood posts resting on the concrete floor supported the beams at 20 ft. intervals. Four 12-inch brick walls, parapeted 12 inches above the roof, divided the 198,000 sq. ft. floor area into four 39,000 sq. ft. storage sections and a 24,000 sq. ft. shipping area. A second story above the shipping area was used as office space.

Of particular interest were the fire doors installed at each of the five openings that pierced each of the four interior fire walls. All were standard labeled, rolling type steel doors, but only one was installed at each opening. This compromise with NFPA Standards for Protection of Openings, which requires a door on each side of the wall at every opening in a fire

Based upon reports submitted by the Pacific Fire Rating Bureau and the San Francisco Fire Dept.

San Francisco Examiner

Substandard protection for fire wall openings, lack of sprinklers, improper storage and inadequate means of access for fire fighting were important factors in the destruction of three of the five sections in this San Francisco grocery warehouse. Two freight doors that jammed when firemen attempted to raise them are visible.



Safeway Stores, Inc. Warehouse, San Francisco Fire, August 30, 1949.

wall, is primarily responsible for the spread of fire to sections adjoining the original fire area. The intense heat so severely warped most of those surrounding the fire that they were unable to hold the fire at the fire walls and were the means of its communication to adjoining sections.

Exterior wall openings (or lack of them) also had an important bearing on the extent of fire damage. A row of small metal frame windows, protected on the interior with heavy gage wire mesh, surrounded the exterior walls at ceiling height. Each of the five sections was provided with two large freight openings protected by single roller steel doors. These were on the sides and rear of the building and were kept locked. The key was not entrusted to the watchman. The only opening in the entire building that was available for fire department use without considerable delay and difficulty was the main entrance in the shipping section.

The building was equipped with a fire department-connected automatic fire alarm system for prompt detection of fire. There was no automatic sprinkler system, however, so that reliance for prompt extinguishment was placed on the public fire department. Since no consideration had been given as to how the fire department would gain access to the building—nearly windowless and locked loading doors—the advantage gained by prompt detection was lost.

Safeway Stores, Inc., occupied this building as its main distributing warehouse for northern California. Large stocks of groceries and household supplies mainly in cardboard cartons and stored on wood pallets occupied all available storage space. To provide additional storage space, the management had eliminated two of the five aisles that normally ran the entire 600 ft. length of the building, closed the fire doors in the eliminated aisles and piled merchandise against and on both

sides of them, also contrary to NFPA Standards. Due to a warehousemen's strike, no stocks had moved in or out of the warehouse for several months.

The Fire

At 12:00 midnight, the night watchman relieved his colleague, locked himself in the building and commenced his rounds of the premises. The fourteen stations were covered by 12:15 A.M. At 12:44 A.M., as he sat writing his report in an office in the shipping section, the watchman was interrupted by the sounding of the horn on the outside of the building connected to the automatic fire alarm system. He proceeded to the adjoining storage Section 1 and on discovering smoke near the ceiling, returned to the main entrance, pulled the fire alarm box and started back to the scene of the fire with a view toward attacking it with an extinguisher. En route the fusible link on the fire door gave way and the door dropped, preventing his entry. The first engine company had arrived by this time in response to the automatic alarm. Firemen laid a hose line in through the main entrance in the shipping section and after raising a fire door and blocking it open entered the adjoining fire area. The smoke became so thick, though, and the heat so intense that conditions soon became unbearable and this position was abandoned. Second alarm companies that arrived five minutes after the first attempted to gain entrance through the locked exterior steel freight doors in the rear, but encountered considerable difficulty. The act of forcing the doors frequently jammed them in their guides, preventing their use. When an opening was finally effected, the interior fire doors to Section 1 had buckled under the heat and wedged in the closed position. Some of these were eventually opened, but the resulting wave of heat forced the hosemen back. The roof of Section 1 had collapsed by then and fire had gained foothold in the shipping section and Section 2 through the pried open and buckled fire doors and by transfer of heat through the blocked doors due to merchandise being stacked against them on either side. Additional alarms were sounded and the combined efforts of 246 firemen directing 62 hose streams for the most part through the collapsed roof succeeded in preventing spread to the remaining sections. The large areas involved, the absence of skylights and the substantially blank wall on the street side gave firemen considerable difficulty during the 17 hours and 25 minutes required for extinguishment. A survey of damage showed the roof of the shipping section and storage Sections 1 and 2 to be destroyed and the contents of this area (112,000 sq. ft.) badly damaged. The two remaining sections were undamaged by fire but sustained smoke and water damage. Estimate of loss includes: building $550,000, stock $2,000,000, and equipment $200,000. Total: $2,750,000.

Cold Storage Plant Fire, Salt Lake City

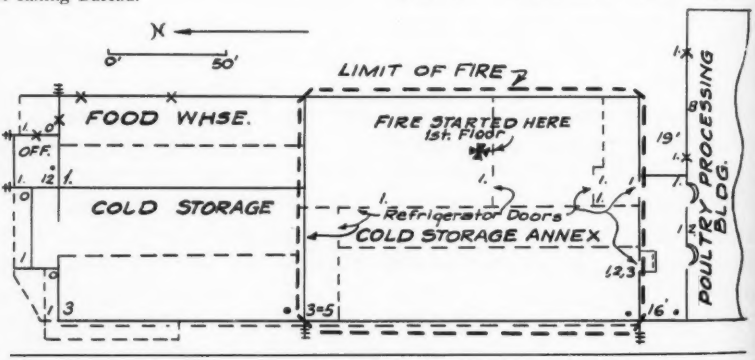
At 4:30 P.M. on June 28, fire was discovered in a refrigerated candy storage room on the first floor of the Annex storage building of the Utah Ice and Storage Company, Salt Lake City, Utah. It had apparently been burning for some time before discovery. Despite prompt response by Salt Lake City firemen, certain structural features common to a large number of cold storage plants (windowless walls and combustible insulation in wall spaces) defeated their efforts to control the fire before destruction of the building. In the absence of an automatic sprinkler system of a design suitable for the freezing tempeartures encountered or at least an automatic detection system, the total loss of a building such as this might have been anticipated.

Construction

The 95 ft. by 143 ft. structure, 54 ft. high, was built in 1920 as an ice house. Walls were constructed of 1-in. by 8-in. sheathing on both sides of 3-in. by 14 in. studs, placed 24 inches on centers, with 4-in. brick veneer on the outside and tongue and groove shiplap facing on the interior. Hollow spaces between studding were filled with sawdust. In 1942, a second and third floor were constructed within the building and the structure converted to a cold storage plant. Floors were 2-inch tongue and groove on 4-in. by 12-in. joists, spaced 14 inches on centers, wood sheathed on the under side. Hollow spaces between joists were filled with sawdust. Wood beams, timbers and columns that supported the floors were not tied into the exterior walls. The roof was composition on wood sheathing on heavy timber trusses.

With the exception of ventilators under the eaves, one door on the west side of the first floor and three small windows in the north wall, there were no openings in this 54-ft. high building, access being through two adjoining and communicating structures. Stairs, chutes and elevators were closed off at each floor with refrigerator

Based upon report submitted by the Utah Fire Rating Bureau.



Utah Storage and Ice Co. Fire, June 28, 1949.

The nearly windowless walls of the Annex storage building of the Utah Ice and Storage Co. were a principal factor in its destruction June 28. The picture shows ventilators under the eaves and the only three windows in the building. Immediately above the roof of the 1-story addition are holes breached by firemen. Difficulty in breathing and danger of explosion of pent-up fire gases prevented inside fire fighting.

type doors, as were openings to the adjoining buildings.

Wood sheathed, sawdust filled partitions with heavy refrigerator doors subdivided floor areas into numerous cold storage rooms cooled by ammonia refrigerating equipment. An estimated 83,400 lbs. of candy, 750,300 lbs. of poultry and 18,790 crates of eggs were in storage on June 28.

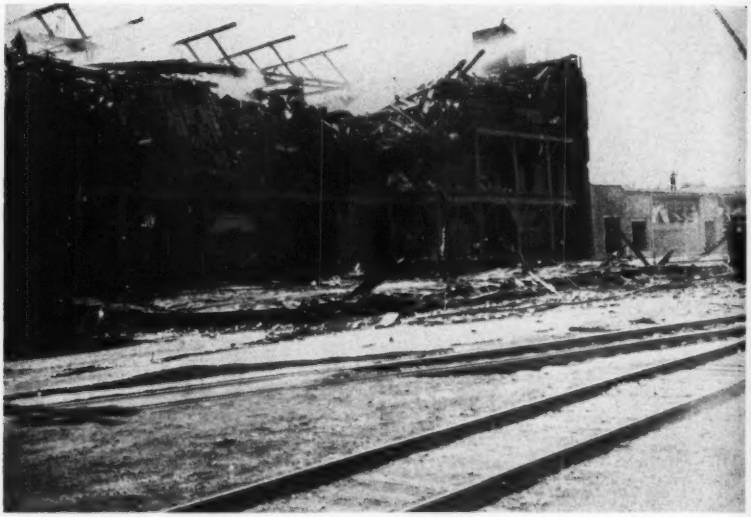
Fire Protection

Private protection consisted of seven anti-freeze solution extinguishers and central station supervised watchman service between 8:00 P.M. and 6:00 A.M. Six hydrants within 750 ft. of the building on 6- and 4-inch circulating mains had an estimated combined fire flow of 4,500 gallons per minute.

The Fire

Fire, originating in the north candy room on the first floor sometime after 3:00 P.M., was not discovered until 4:30 P.M. when an employee passing through an adjacent storage room smelled smoke. Five employees had been working in the south entrance to the building during the afternoon, but the airtight construction prevented the smoke from reaching them. When investigation revealed the north storage room to be full of smoke (no flame visible), men were sent for extinguishers and the alarm telephoned. During operation of extinguishers, flames began to appear, but were largely subdued. However, smoke and heat became so intense that the men were driven from the room.

Arriving at 4:47 P.M., the first fire company ran a line from the nearest hydrant, but was forced to transfer to another when the water main connection broke at the base. Eventually lines were directed through doorways at both ends of the north candy room but not before fire had



The 54 ft.-high windowless west wall of the Annex storage building fell to the ground at 7:05 A.M., exposing combustible interior construction, sawdust filled floors and concentrated crated storage.

burned through interior wood sheathing, and burned up to the second floor through sawdust filled wall spaces.

The severity of the fire was not apparent from the outside because of the almost windowless walls, which not only retarded escape of smoke and flames but also prevented direct access of hose streams to upper floors. A second alarm was sounded at 5:02 P.M., and a general alarm at 5:14 P.M. Ladder companies breached two holes in the east wall, first floor, and one on the second floor. Two other holes were breached in the north wall, second floor, just above the roof of the adjoining 1-story storage building. Lines were laid to these holes as other firemen wearing self-contained air and oxygen breathing equipment manned hose lines within the building. Several were overcome by smoke and carried from the building.

By 7:30 P.M., while flames on the first floor had for the most part been brought under control, despite all efforts the fire continued to develop in intensity and involved most of the second and third floors with their concentrated storage of eggs and poultry in paper bags and crates.

The danger of ammonia release and explosion was relieved when ammonia in the refrigeration system was pumped back to the main ice plant. However, the threat of an explosion of pent up fire gases increased in the practically windowless building which could not be ventilated properly during this stage of the fire fighting, and all firemen were withdrawn from the interior of the structure at 8:00 P.M. From then on the fire was fought with hand lines at access openings and with heavy stream devices. At 11:30 P.M., dense smoke in large quantities was issuing from the ventilators under the eaves, and east and west walls began to bulge. At 11:50 P.M., fire broke through and quickly enveloped the roof, and 45 min-

utes later the upper ten feet of the northwest corner fell in. A noticeable improvement in the effectiveness of hose streams was apparent thereafter, and despite the danger from falling wall sections firemen were able to confine the fire to the Annex and to complete extinguishment by the afternoon of June 30 — a remarkable achievement in the light of the inadequate cut-offs between the Annex and communicating exposures.

Loss estimates totaling $1,250,000, include $200,000 damage to the building and equipment and $1,050,000 to contents. Estimates of business interruption insurance loss are not yet available.

Cause

Investigation by the Fire Marshal and Chief Electrical Inspector of Salt Lake City disclosed that the fire started in or near an electric motor used to operate a blower in the north candy room. A joint statement issued by these officials placed the cause of the fire on a "short, caused by improper wire with improper insulation in an improper conduit, coupled with an amateur job of wiring." The wiring in the building which was substandard in other respects, also, had never been inspected by the city electrical department following extensive changes which had been made since the original conduit system was installed.

St. Louis Mortuary Fire

Control of fire in attics of combustible construction, inaccessible and not readily ventilated is a difficult and often insurmountable task for fire fighters. The fire on August 5, in the 4-foot-high blind attic at Kriegshauser Mortuaries, Inc., St. Louis, Mo., was no exception. The one inescapable conclusion to be reached from the costly evidence of such fires is the need of an automatic sprinkler system if inaccessible attics containing burnable material are to be adequately protected against fire.

Kriegshauser's Mortuary occupied a large area, 1-story stuccoed brick building for funeral services, casket display and embalming. A parapeted fire wall with protected openings on the first floor divided the structure into 11,400 sq. ft. and 3,900 sq. ft. areas known respectively as the north and south sections. Between the tile and composition covered flat, wood-joisted roof and the first floor ceiling, a 4-foot-high blind attic (divided by the fire wall) extended over the entire building. The single access to the area above the north section was a hatchway without stairs. Throughout this unfinished area, insulation consisting of lightly compressed combustible fibre matting had been placed between exposed floor joists and nailed to studding.

On August 5, electricians were on the premises installing new lighting fixtures in the chapel in the north section. Additional wiring required by the job had been laid on top of wood joists and unprotected steel beams in the attic and placed in service. At 3:53 P.M., when smoke was observed coming from the roof by a mortuary employee, three soda-acid extinguishers were taken to the attic of the north section and discharged on a fire found burning in fibre matting in the

Based upon reports submitted by Missouri Inspection Bureau and St. Louis Fire Department.

St. Louis Globe-Democrat

A single hatchway was the only access to the 4-foot-high blind attic of the St. Louis Mortuary. Fire in the attic burned in combustible insulating material out of reach of hose streams until most of the roof had been chopped or burned away.

vicinity of the newly installed wiring. The fire continued to burn after the extinguishers were emptied, so the fire department was called. Ladders were raised, the roof pierced and streams directed on the blaze. All visible flame was soon extinguished and orders were about to be given to return to quarters when several other widely scattered fires were found burning in fibre insulating material. These rapidly spreading inaccessible fires soon merged into one continuous blaze that could not be controlled until practically the entire roof had been opened either by firemen or by flames. Streams from three ladder pipes were then placed in operation which, in combination with hand lines directed through holes chopped in the metal lath and plaster ceiling gradually overpowered the fire and had it out at 10:40 P.M. The roof and first floor ceiling of the north section were destroyed, but fire did not extend beyond the fire wall to the south section. Loss estimates totaling $255,000 include Use and Occupancy loss of $60,000.

Fire Hazard Tests With Masonry Chimneys

By Nolan D. Mitchell

Loss of dwellings and the lives of their occupants from fire in the United States are appalling. Many of these fires are attributable to defective chimneys and fuel-fired heating equipment. Prior to the investigation reported here there were few technical data available from tests with conventional masonry chimney construction, and regulations governing the construction of such chimneys and their surroundings were largely based on judgment and experience. Unfortunate experiences with various types of chimneys which caused fires in government housing during the war prompted the National Housing Agency, now the Housing and Home Finance Agency, to request the National Bureau of Standards to make tests of various types of conventional masonry chimneys to determine the hazards they present and to determine what could be done to reduce any hazards found in the test program. Two series of tests of masonry chimneys have been made and preliminary reports have been issued on each. A report consolidating the data of the two series has recently been submitted to the sponsoring agency.

Twenty-one masonry chimneys were subjected to about 200 tests with coal, wood and gas fuels to determine the hazard of ignition of adjacent woodwork. Kindling wood fires in a large heating stove raised the flue gas to 1700°F in five minutes and 1800°F in 10 minutes. The temperature could be sustained by frequent firing with wood or coal at or above an average of 1200°F for 5½ hours. Tests were made with the two-inch space between the chimney and floor framing unfilled (see Fig. 11), then with the space filled with mineral wool, and finally with the space filled with broken brick and mortar, without reduction in temperature of the wood floor joists. The test results in-

Masonry units used in chimney construction. Members shown indicate the test chimney numbers listed in Table I. Brick — 1, 2, 3, 4, 5, 6; Sand Cement Brick — 17; Tile — 7, 8, 9; Cinder Concrete Chimney Units — 15, 16; Cinder Concrete Block (liner cast integrally) — 21.

This paper, under the title, "What Is A Safe Chimney?" was presented by Mr. Nolan D. Mitchell, Chief, Fire Protection Section, Building Technology Division, National Bureau of Standards, at the NFPA Annual Meeting in May, 1949.

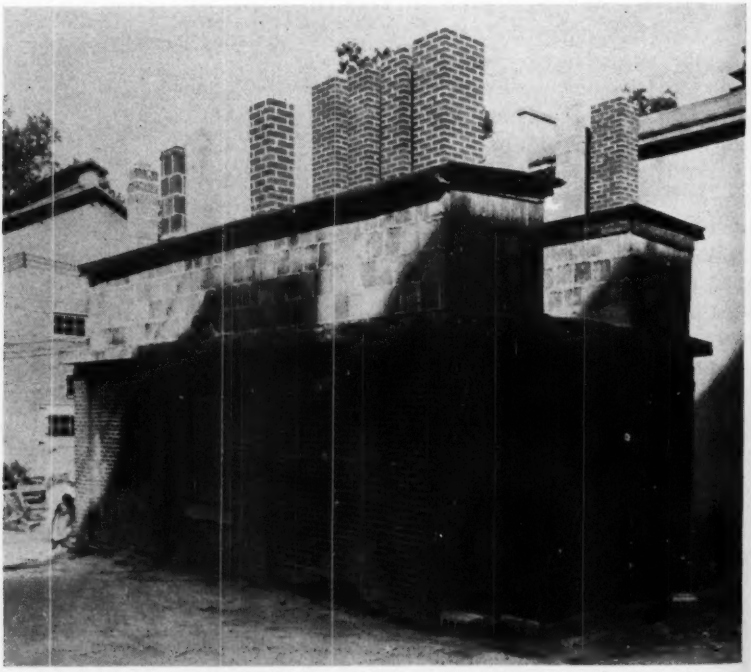
dicated that contact of woodwork with the chimney should be restricted to corner locations. Fire stopping should be restricted to not more than 1 in. depth at the bottom of the joist space.

Scope of Investigation

Of the twenty-one masonry chimneys built for the tests, there were three kinds of brick chimneys, three kinds of tile chimneys, three kinds of cinder or sand concrete block chimneys, and five kinds of chimney units used. Typical units used in the construction of the chimneys tested are shown on page 117.

Three kinds of flue liners were included. Some were made of local clay, some of Ohio fire-clay, one was of vitreous enameled steel, and one 8- by 8-in. flue was unlined except for a thin coating of mortar. The local-clay and fire-clay liners were of nominal 8-in. square or 8-in. by 12-in. rectangular size and the round ones 7-in. and 10-in. internal diameter. The 7-in. diameter enameled liner and the 7-in. diameter fire-clay liner had the space between the liners and the brickwork enclosure filled with granular expanded rhyolite insulation.

Two of the chimneys with square liners and two with rectangular liners had the space between the liners and surrounding masonry filled solidly with mortar; the others which had clay liners had them set with only small amounts of mortar (pats) to stay them.



Test structure at the National Bureau of Standards in which 21 kinds of masonry chimneys were built and more than 200 tests conducted to determine the hazards they present.

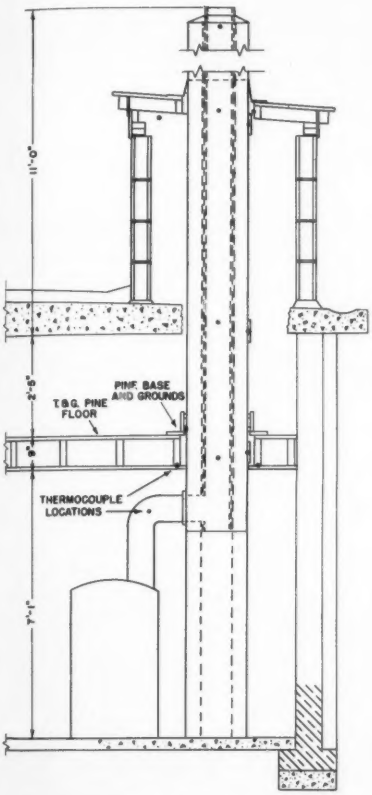


Fig. 1. Section of test structure, showing floor and roof construction and location of thermocouples.

Two of the chimneys made of concrete chimney blocks had 8½-in. diameter concrete liners cast integrally with the blocks. These chimneys cracked early in the tests and the investigations with them were discontinued.

The chimneys were erected in the building shown in the illustration on page 118, with details as shown in Figures 1 and 2. Thermocouple locations are also shown in Figures 1 and 2. Hot flue gases were derived at first from wood or coal stoves of several commercial types, the largest of which was a U. S. Army No. 20 Cannon stove (Figure 2). After determinations were obtained on temperatures developed in the flue gases, gas-fired burners were installed to provide for closer temperature control than was possible with the stoves.

Method of Test

Data from 111 tests considered significant are contained in Table I. Temperatures were measured* in the more significant locations, in the flues, on the outside surfaces of the masonry, on wood in contact with the masonry such as plaster

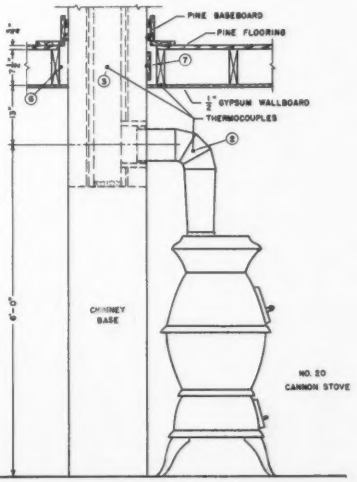


Fig. 2. Placement of stove for heat shock test and arrangement of construction surrounding the chimney and location of thermocouples.

*Temperatures were measured by means of chromel-alumel thermocouples and portable type potentiometers. The thermocouple junctions within the flues were not provided with protection to prevent contamination by the flue gases. They were, however, usually replaced before such contamination seriously affected them. Except at or near the junction of the thermocouple wires, insulations of porcelain, asbestos or fibreglass were provided.

TABLE I. TEST RESULTS.

Chimney Number and Kind	Test: Number or Date	Test: Duration Hrs.:Min.	Heating Device	Fuel	Fill in Floor Space	Flue Gas Temperature at Floor Level °F	Maximum Temperature Rise (Above Room Temperature): Chimney Surface Under Pad °F	Maximum Temperature Rise (Above Room Temperature): Against Side of Floor Joists °F	Maximum Temperature Rise (Above Room Temperature): Under Baseboard Ground °F	Remarks
SHALE BRICK										(Average Flue Gas Temperature duration of test minus 1 hour)
No. 1. Shale Brick, Cored (Ten ½-inch holes) Lined 8¼ x 8¼ in.	6/6/44	5:15	Stiglitz, warm morning	Hard and soft coal	None	753 Av.	216*	149*	176*	750°F
	6/7/44	7:45	Stiglitz, warm morning	Hard and soft coal	None	658 "	145	101	110	642
	6/29/44	3:30	Stiglitz, warm morning	Soft coal, med. size	None	886 "	185	128*	172	904
	6/30/44	3:00	Agricola cast iron	Soft coal and wood	None	856 "	205	128*	163*	1085
	7/1/44	5:00	Agricola cast iron	Soft coal and wood	None	825 "	224	163*	194	885
	11/7/44	6:45	Gray & Dudley Hot Blast	Wood	None	1025 "	389	242	318	1080
	11/8/44	4:00	Gray & Dudley Hot Blast	Wood	None	885 "	—	146*	150*	866
	11/9/44	4:10	Gray & Dudley Hot Blast	Wood	None	800 "	—	163*	216*	827
	11/13/44	5:40	Reeve sheet steel airtight	Wood	None	1087 "	—	326	411	1255
	11/16/44	6:00	Reeve sheet steel airtight	Wood	None	1093 "	—	295	344	1135
	5/27/44	12:30	Venturi Burner	Gas	None	900	291	220	278	
	5/30/44	13:45	Venturi Burner	Gas	None	1101	385	243	327	
	6/1/44	7:00	Venturi Burner	Gas	None	1202	500*	318*	381*	Wood charred, removed at 7 hr.
	5/23/44	6:40	Venturi Burner	Gas	None	1300	425	300	411*	Wood smoking at 6 hr., removed at 6:40.
	7/4/44	8:00	Venturi Burner	Gas	None	1400/1000	309*	229*	251*	
No. 4. Shale Brick, Lined 8 x 12 in.	20B	6:00	Venturi Burner	Gas	None	990	240	148	207	
	21B	7:00	Venturi Burner	Gas	None	893	216	112	177	
	22B	7:20	Venturi Burner	Gas	None	1100	335*	214*	313*	Ground strip glowing. Initial temp. 135°F.
	24B	12:05	Venturi Burner	Gas	None	1000/1400	456	274	401	Ground strip smoking, removed.
	41B	12:50	Venturi Burner	Gas	Mineral wool†	1400/1000	436	197	330	
	42B	17:00	Venturi Burner	Gas	Brick and mortar	1400/1000	377	272	310	
Plastered	109A	14:00	Venturi Burner	Gas	None	1100	—	287	414	
No. 5. Shale Bricks, 2 Flues Lined Each 8 x 12	45B	12:00	Venturi Burner	Gas	None	800	293	208	133	
	46B	9:20	Venturi Burner	Gas	None	1400/1000	398	254	257	
	47B	11:00	Venturi Burner	Gas	Mineral wool†	1400/1000	468*	214	290	Fire in ground strip.
	48B	14:40	Venturi Burner	Gas	Brick and mortar	1400/1000	389	232	209	
No. 6. Shale Bricks, Lined 16 in. in diameter	51A	10:20	Venturi Burner	Gas	None	1400/1000	286	182	220	
	52A	13:50	Venturi Burner	Gas	None	1200	376	248	299	
	53A	9:00	Venturi Burner	Gas	Mineral wool†	1400/1000	297	103	193*	
	55A	12:50	Venturi Burner	Gas	Brick and mortar	1400/1000	325	217	225	

No. 6. Shale Bricks, Lined 10 in. in diameter	51A	10:20	Venturi Burner	Gas	None	1400/1000	280	182	225	
	52A	13:50	Venturi Burner	Gas	None	1200	376	248	299	
	53A	9:00	Venturi Burner	Gas	Mineral wool†	1400/1000	297	103	193*	
	55A	12:50	Venturi Burner	Gas	Brick and mortar	1400/1000	325	217	225	

CLAY BRICK

										(Average Flue Gas Temperature duration of test minus 1 hour)
No. 2. Clay Brick, Solid, Unlined 9 x 9 in. inside dimension	6/6/44	5:45	Knox Twin-Temp. No. 820	Hard and soft coal	None	726 Av.	220*	127*	193*	770°F
	6/7/44	7:00	Knox Twin-Temp. No. 820	Hard and soft coal	None	636 "	190	110	159	650
	6/30/44	7:01	Knox Twin-Temp. No. 820	Soft coal	None	774 "	279	160	229	664
	7/1/44	5:40	Knox Twin-Temp. No. 820	Soft coal	None	930 "	372	225	320	954
	11/16/44	6:25	Gray & Dudley Hot Blast	Wood	None	770 "	371	242	331	810
	5/27/44	13:30	Venturi Burner	Gas	None	903	349	229	327	
	5/22/44	3:55	Venturi Burner	Gas	None	1027	530*	318*	784*	Glow in wood at 3:10.
	5/30/44	1:00	Venturi Burner	Gas	None	1400	358	158	282	Max. temp. rises 40 to 70 min. after gas off.
										(Average Flue Gas Temperature duration of test minus 1 hour)
No. 3. Clay Brick, Cored (Six 1⅛ in. holes), Lined 8 x 12 in.	25A	2:25	Cannon	Wood	None	1317 Av.	250*	117*	(Plaster	1200°F
	26A	2:05	Cannon	Wood and soft coal	None	1400 "	255*	127*	ground	1280
	27A	1:35	Cannon	Soft coal and wood	None	1520 "	119*	62*	omitted)	1440
	28A	1:15	Cannon	Wood	None	1670 "	164*	70*		1170
	29A	5:35	Cannon	Soft coal	None	1190 "	471	232		1270
	30A	5:30	Cannon	Wood—soft coal	None	1200 "	437	247		1282
	31A	5:25	Cannon	Soft coal	None	1083 "	420	209		1145
	32A	4:45	Cannon	Soft coal	None	900 "	283*	144*		885
	20A	6:00	Venturi Burner	Gas	None	980	193*	108*	163*	
	21A	7:00	Venturi Burner	Gas	None	877	209	108	168	Ground strip charred. Initial temp. 131°F.
	22A	7:20	Venturi Burner	Gas	None	1100	321*	178*	302*	
	23A	7:35	Venturi Burner	Gas	None	1400/1000	367	193	299	
	24A	12:05	Venturi Burner	Gas	None	1000/1400	444	232	401*	Ground strip smoking, removed at 12:33.
	41A	12:50	Venturi Burner	Gas	Mineral wool†	1400/1000	490	205	346	
	42A	17:00	Venturi Burner	Gas	Brick and mortar	1400/1000	530	279	317	

SAND CEMENT BRICK.

No. 17. Sand Cement Brick, Lined 8 x 12 in.	107B	7:10	Venturi Burner	Gas	None	1400/1000	433*	241*	319*	Fire in ground strip at 7:05.
	108B	7:30	Venturi Burner	Gas	None	1000	396	175	—	
	109B	14:03	Venturi Burner	Gas	None	1100	549	254	378	
	110B	7:00	Venturi Burner	Gas	None	1200	533*	281*	371*	Ground strips removed at end of test.
	113B	11:40	Venturi Burner	Gas	Brick and mortar	1400/1000	486*	295*	360*	
	114B	11:40	Venturi Burner	Gas	Brick and mortar	1100	530	321	365*	Test structure burned during night.

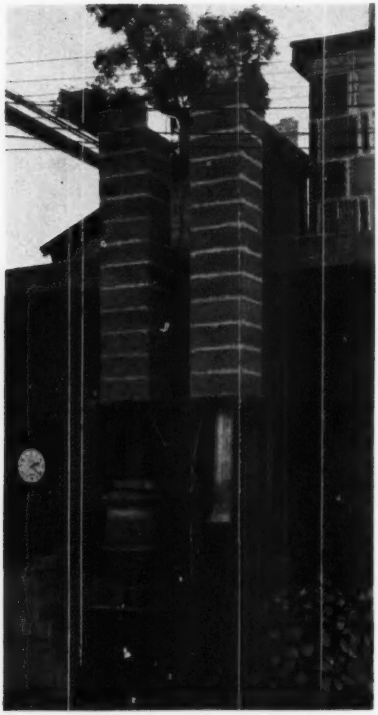
*Temperature rising at time of last reading.
†5 lbs. mineral wool used to fill joist space.

TABLE I. TEST RESULTS — Continued.

Chimney Number and Kind	Test		Heating Device	Fuel	Fill in Floor Space	Flue Gas Temperature at Floor Level °F	Maximum Temperature Rise (Above Room Temperature)			Remarks
	Number or Date	Duration Hrs.:Min.					Chimney Surface Under Pad °F	Against Side of Floor Joists °F	Under Baseboard Ground °F	
CINDER OR SAND CONCRETE BLOCKS.										
No. 12. Cinder Concrete Block, 23% Voids, Lined 8 x 8 in.	33A	9:30	Venturi Burner	Gas	None	1000	360	144	241	
	36A	14:00	Venturi Burner	Gas	None	1000	321	211	289	
	34A	11:40	Venturi Burner	Gas	None	1200	522	212	360	
	35A	12:00	Venturi Burner	Gas	None	1400/1000	273	142	243	
	37A	10:30	Venturi Burner	Gas	None	1400/1000	326	214	282	
	38A	14:20	Venturi Burner	Gas	Mineral wool†	1400/1000	677*	392	347	Joist glowed at 14:20.
	40A	14:20	Venturi Burner	Gas	Brick and mortar	1400/1000	493	287	302	
No. 13. Cinder Concrete Block, Solid, Lined 8 x 8 in.	33B	9:30	Venturi Burner	Gas	None	1000	—	131*	229*	
	36B	14:00	Venturi Burner	Gas	None	1000	326	194	295	
	34B	11:40	Venturi Burner	Gas	None	1200	—	164	270	
	35B	12:00	Venturi Burner	Gas	None	1400/1000	295	160	229	
	37B	10:30	Venturi Burner	Gas	None	1400/1000	313	194	275	
	38B	14:20	Venturi Burner	Gas	Mineral wool†	1400/1000	585*	234	583*	Glow in ground strip at 14:20.
	39B	13:00	Venturi Burner	Gas	Mineral wool*†	1400/1000	457	207*	468*	Fire in ground strip at 13:08.
	40B	14:20	Venturi Burner	Gas	Brick and mortar	1400/1000	349	202	276	
No. 18. Concrete Block, 26% Voids, Lined 8 x 8 in.	113A	11:40	Venturi Burner	Gas	None	1400/1000	353	160	338*	
	114A	11:40	Venturi Burner	Gas	None	1100	375	169	351	Destroyed by fire after test 114B.
TILE.										
No. 7. Shale Tile, 16% Voids Lined 8 x 12 in.	81B	11:00	Venturi Burner	Gas	None	1400/1000	297	175	275	
	82B	7:30	Venturi Burner	Gas	None	1200	408*	270*	365*	Glow in ground strip at 7:30.
	83B	8:10	Venturi Burner	Gas	1" mortar	1400/1000	—	198*	281*	
	84B	10:20	Venturi Burner	Gas	Brick and mortar	1400/1000	346*	209*	315*	
No. 8. Semi-fire Clay Tile, 25% Voids, Lined 8 x 12 in.	81A	11:00	Venturi Burner	Gas	None	1400/1000	321	229	289	
	82A	7:30	Venturi Burner	Gas	None	1200	425*	264*	378*	Glow in ground strip at 7:30.
	83A	8:10	Venturi Burner	Gas	1" mortar	1400/1000	326	204	308*	
	84A	10:20	Venturi Burner	Gas	Brick and mortar	1400/1000	364*	324*	330*	

Clay Tile, 25% Voids, Lined 8 x 12 in.	82A	7:30	Venturi Burner	Gas	None	1200	425*	264*	378*	Glow in ground strip at 7:30.
	83A	8:10	Venturi Burner	Gas	1" mortar	1400/1000	326	204	308*	
	84A	10:20	Venturi Burner	Gas	Brick and mortar	1400/1000	364*	324*	330*	
No. 9. Shale Partition Tile, 4 x 12 x 12 in. Lined 8 x 12	73A	9:40	Venturi Burner	Gas	None	800	241	126	180	
	74A	8:40	Venturi Burner	Gas	None	1200	414	171	321	Glow in ground strip at 8:45.
	75A	9:40	Venturi Burner	Gas	None	1400/1000	328	195	260	
	76A	9:00	Venturi Burner	Gas	1" mortar	1400/1000	314	166	227	
	77A	0:30	Venturi Burner	Gas	1" mortar	increasing to 1740	225	83	122	
	78A	16:00	Venturi Burner	Gas	1" mortar	1400/1000	338	189	239	
	79A	9:40	Venturi Burner	Gas	Brick and mortar	1400/1000	325	156	209	
CHIMNEY UNITS.										
No. 14. Cinder Concrete Chimney Units, Lined 8 x 12 in.	74B	8:45	Venturi Burner	Gas	None	1200	310*	211*	305*	
	75B	9:40	Venturi Burner	Gas	None	1400/1000	254	166	260	
	76B	9:00	Venturi Burner	Gas	1" mortar	1400/1000	219	166	236	
	78B	16:00	Venturi Burner	Gas	1" mortar	1400/1000	254	189	293	
	79B	9:40	Venturi Burner	Gas	Brick and mortar	1400/1000	247	170	261	
No. 15. Cinder Concrete Chimney Units, Lined 8 x 8 in.	65B	13:20	Venturi Burner	Gas	None	1400/1000	292	230	284	
	66B	9:05	Venturi Burner	Gas	None	1200	349*	271*	336*	Ground strip charred. No glow.
	68B	13:00	Venturi Burner	Gas	None	1000/1400	349*	299*	398*	
	70B	9:00	Venturi Burner	Gas	Mineral wool†	1400/1000	310*	277*	362*	
	71B	11:00	Venturi Burner	Gas	Brick and mortar	1400/1000	299	230	292	
No. 16. Cinder Concrete Chimney Units, Lined 8 x 8 in.	65A	13:20	Venturi Burner	Gas	None	1400/1000	290	221	257	
	66A	9:06	Venturi Burner	Gas	None	1200	392*	288*	347*	Flame in baseboard.
	69A	9:40	Venturi Burner	Gas	None	1400/1000	347	243	410*	Glow in ground strip.
	68A	13:00	Venturi Burner	Gas	None	1000/1400	436*	310*	580*	Fire in ground strip at 13:40.
	70A	9:00	Venturi Burner	Gas	Mineral wool†	1400/1000	375*	200*	452*	Glow in ground strip at 9:00.
	71A	11:00	Venturi Burner	Gas	Brick and mortar	1400/1000	328	272	340	
No. 19. Sand Concrete Chimney Unit, Lined 8 x 8 in.	102A	8:00	Venturi Burner	Gas	None	800	468*	192*	341*	
	103A	5:20	Venturi Burner	Gas	None	1000	551*	232*	448*	Fire in ground strip at 5:20.
	104A	11:40	Venturi Burner	Gas	None	800	497	277	353*	
	105A	6:40	Venturi Burner	Gas	None	905	—	238*	306*	Fire in ground strip after tests.
No. 21. Concrete Chimney Unit, Liner cast integrally	Two tests were made, one chimney of cinder concrete, one with sand as concrete aggregate. Both cracked through the shell and liner under minor heat shock. Investigations discontinued.									

*Temperature rising at time of last reading.
†5 lbs. mineral wool used to fill joist space.
**10 lbs. mineral wool used to fill joist space.



Test arrangements at the National Bureau of Standards for cinder concrete block with liner cast integrally, wood and coal fuel. These chimneys cracked through the shell and liner under minor heat shock.

grounds and baseboards, on the wood floor joists 2 in. away from the chimney, in the space near the chimney and just under the roof as shown in Figure 1.

Tests were usually made first without fill between the chimney and surrounding woodwork. Fills of mineral wool were then provided between the chimney and wood floor joists. These fills were replaced with those made of broken brick and mortar on a metal lath strip to bridge the space between the joists and the chimney, thus forming a noncombustible fire stop at the bottom of the 2-in. wide space. Since it was impracticable to apply plaster above the top plaster ground, mineral wool was placed between the top of the baseboard and the chimney to prevent free convection currents of air rising between the chimney and baseboard.

Various types of stoves were fired with solid fuels such as wood, hard coal, bituminous coal or mixtures of these to obtain information about flue gas temperatures under several conditions of firing. Gas burners supplied with gas through meters and needle valve controls were used for most of the tests. Many of the tests were made by bringing the flue gas temperature up to a predetermined value at the level of the floor framing and holding it constant until the temperature under a 6-in. square by 0.4-in. thick felted asbestos pad on the chimney surface at the same level ceased to rise. Other tests were made with flue gas at 1400°F for the first hour followed by flue gas at 1000°F until a steady state of temperature under the pad was obtained (1400/1000 Tables I and II). A few tests were made with the order reversed, that is, with flue gas at 1000°F for 7 hours followed by flue gas at 1400°F for one hour (1000/1400 Tables I and II). Shock tests of ½-hour duration were made with flue gas temperatures rapidly rising to the range from 1400° to 1800°F. The shock tests were made to determine the degree of resistance to breaking and dislodging of flue liners and whether the masonry would be cracked by such drastic treatment.

Subsequent to the heat shock tests all the flue linings and masonry structure surrounding them were examined either by dismantling the chimney or by careful inspection.

Results of Tests

A summary of the results of 111 tests with the several kinds of masonry chim-

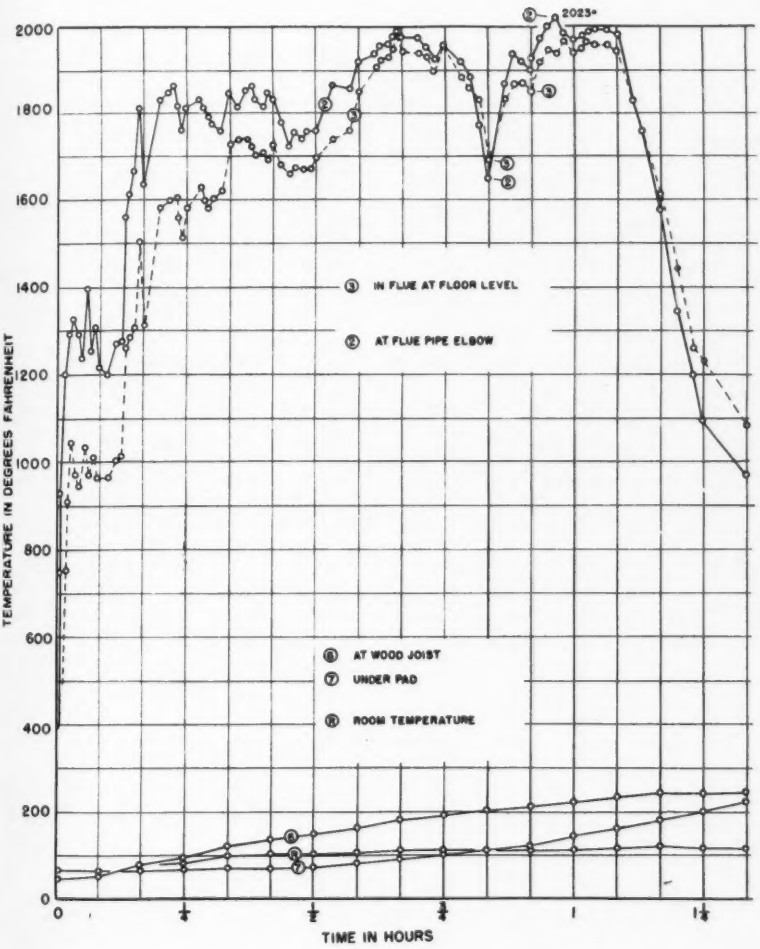


Fig. 3. Temperatures developed from a wood fire in a No. 20 U. S. Army Cannon stove. (See also Fig. 2.)

TABLE II. TEST RESULTS — RANGE OF TEMPERATURE RISE.

	No. of Tests	Duration Hrs.: Min.	Fuel	Fill in Floor Space	Flue Gas Temperature at Floor Level °F	Range of Temperature Rise* (Above Room Temperature)			Remarks
						Chimney Surface Under Pad °F	Against Side of Floor Joists °F	Under Baseboard Ground °F	
Shale Brick, Lined Chimneys No. 1, 4, 5, 6	10	3:00-7:45	Coal or Wood	None	658-1093†	145-389	101-326	110-411	
	9	6:00-13:50	Gas	None	893-1300	216-500	112-318	133-411	3 fires
	1	14:00	Gas	None	1100	...	287	414	Plastered chimney surface
	1	12:05	Gas	None	1000/1400	456	274	401	1 fire
	3	8:00-10:20	Gas	None	1400/1000	286-398	182-254	220-257	
	3	9:00-12:50	Gas	Mineral Wool**	1400/1000	297-468	103-214	193-330	1 fire
	3	12:50-17:00	Gas	Brick and Mortar	1400/1000	325-389	217-272	225-310	
Clay Brick, Solid, Unlined Chimney No. 2	5	5:40-7:01	Coal or Wood	None	636-930†	190-372	110-242	159-331	
	3	1:00-13:30	Gas	None	903-1400	349-530	158-318	282-784	1 fire
Clay Brick, Cored, Lined Chimney No. 3	8	1:15-5:35	Coal or Wood	None	900-1670†	119-471	62-247	Plaster Ground Omitted	
	3	6:00-7:20	Gas	None	877-1100	193-321	108-178	163-302	1 fire
	1	12:05	Gas	None	1000/1400	444	232	401	1 fire
	1	7:35	Gas	None	1400/1000	367	193	299	
	1	12:50	Gas	Mineral Wool**	1400/1000	490	205	346	
	1	17:00	Gas	Brick and Mortar	1400/1000	530	279	317	
Sand Cement Brick, Lined Chimney No. 17	3	7:00-14:30	Gas	None	1000-1200	396-549	175-281	371-378	
	1	7:10	Gas	None	1400/1000	433	241	319	1 fire
	1	11:40	Gas	Brick and Mortar	1400/1000	486	295	360	
	1	11:40	Gas	Brick and Mortar	1100	530	321	365	Structure burned
Cinder Concrete Block, 23% Voids, Lined Chimney No. 12	3	9:30-14:00	Gas	None	1000-1200	321-522	144-212	241-360	
	2	10:30-12:00	Gas	None	1400/1000	273-325	142-214	243-282	
	1	14:20	Gas	Mineral Wool**	1400/1000	677	392	347	1 fire
	1	14:20	Gas	Brick and Mortar	1400/1000	493	287	302	

TABLE II. TESTS RESULTS — RANGE OF TEMPERATURE RISE — Continued.

	No. of Tests	Duration Hrs.:Min.	Fu	Fill in Floor Space	Flue Gas Temperature at Floor Level °F	Range of Temperature Rise* (Above Room Temperature) Chimney Surface Under Pad °F	Against Side of Floor Joists °F	Under Baseboard Ground °F	Remarks
Cinder Concrete Block, Solid, Lined Chimney No. 13	3	9:30-14:00	Gas	None	1000-1200	...-326	131-194	229-295	
	2	10:30-12:00	Gas	None	1400/1000	295-313	160-194	229-275	
	1	14:20	Gas	Mineral Wool**	1400/1000	585	234	583	1 fire
	1	13:00	Gas	Mineral Wool***	1400/1000	457	207	468	1 fire
	1	14:20	Gas	Brick and Mortar	1400/1000	349	202	276	
Concrete Block, 25% Voids, Lined Chimney No. 18	1	11:40	Gas	None	1100	375	169	351	1 fire
	1	11:40	Gas	None	1400/1000	353	160	338	
Cinder Concrete Chimney Units, Lined Chimneys No. 14, 15, 16	3	8:45-9:05	Gas	None	1200	310-392	211-288	305-347	2 fires
	2	13:00	Gas	None	1000/1400	349-436	299-310	398-580	1 fire
	4	9:40-13:20	Gas	None	1400/1000	254-347	166-243	257-410	1 fire
	2	9:00-16:00	Gas	1" Mortar	1400/1000	219-254	166-189	236-293	
	2	9:00	Gas	Mineral Wool**	1400/1000	310-375	200-277	362-452	1 fire
	3	9:40-11:00	Gas	Brick and Mortar	1400/1000	247-328	170-272	261-340	
Sand Concrete Chimney Units, Lined Chimney No. 19	4	5:20-11:40	Gas	None	800-1000	468-551	192-277	306-448	2 fires
Shale Tile, 16% Voids, Lined Chimney No. 7	1	7:30	Gas	None	1200	408	270	365	1 fire
	1	11:00	Gas	None	1400/1000	297	175	275	
	1	8:10	Gas	1" Mortar	1400/1000	...	198	281	
	1	10:20	Gas	Brick and Mortar	1400/1000	361	324	330	
Semi Fire Clay Tile, 25% Voids, Chimney No. 8	1	7:30	Gas	None	1200	425	264	378	1 fire
	1	11:00	Gas	None	1400/1000	321	229	289	
	1	8:10	Gas	1" Mortar	1400/1000	325	204	308	
	1	10:20	Gas	Brick and Mortar	1400/1000	364	324	330	
Shale Partition Tile, 4x12x12 in., Lined Chimney No. 9	2	8:40-9:40	Gas	None	800-1200	241-414	126-171	180-321	1 fire
	1	9:40	Gas	None	1400/1000	328	195	260	
	1	0:30	Gas	1" Mortar	increasing to 1740	225	83	122	
	2	9:00-16:00	Gas	1" Mortar	1400/1000	314-338	166-189	227-239	
	1	9:40	Gas	Brick and Mortar	1400/1000	325	156	209	

*See Figures 8, 9, and 10 for comparative trends in temperature rise for various kinds of chimneys.
**5 lbs. mineral wool used to fill joist space.
***10 lbs. mineral wool used to fill joist space.
†Average Flue Gas Temperature at Floor Level.

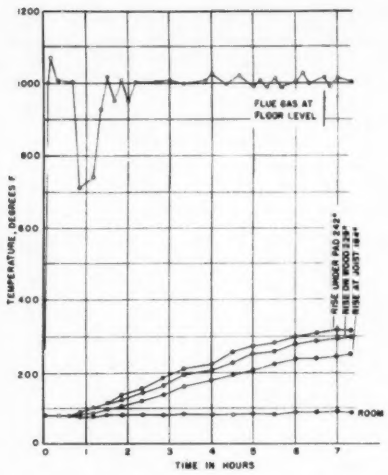


Fig. 4. Temperatures developed with a lined brick chimney by a gas-fired burner.

neys under varied test conditions is contained in Table II. It will be noted that duration of the test, fuel used, the presence or absence of noncombustible fill in the joist space, and the flue gas temperature at the floor level significantly affect the range of temperature rise (above room temperature) on the surface of several chimneys (under a pad), on the side of floor joists and under baseboard grounds, and that in 24 cases ignition of adjacent woodwork was observed. Examination of the chimneys subjected to heat shock tests showed that all liners were cracked. A few were badly broken but all remained in place. All the chimney walls were cracked to some extent. Smoke introduced into the hot chimneys after the shock tests issued from one or more cracks in each. Cracks in brickwork extended across a few units. Those in chimneys constructed of tile or concrete blocks were usually in the mortar joints, whereas those in the cinder concrete chimney units extended through the units' walls on opposite sides of the chimney. Those chimneys having the liners slushed in solidly with mortar had some cracks in the liner coincident and continuous with the cracks in the masonry, whereas cracks in chimneys with liners held by only small amounts of mortar were usually not continuous and coincident.

Wood and Coal Fires.—Flue gas temperatures produced by small amounts of wood kindling rose rapidly to values up to 1700°F in five minutes and to 1800°F in 10 minutes after lighting the fire. The flue gas temperature varied rapidly in consequence of the firing operations, the averages for the period of the 23 tests with stoves ranged from 636° to 1670°F with durations varying from 1¼ to 7¾ hours. The rises of temperature on the chimney surface at the floor framing level resulting from these tests ranged from 119° to 471°F. Those on the wood plaster grounds ranged from 110° to 411°F and

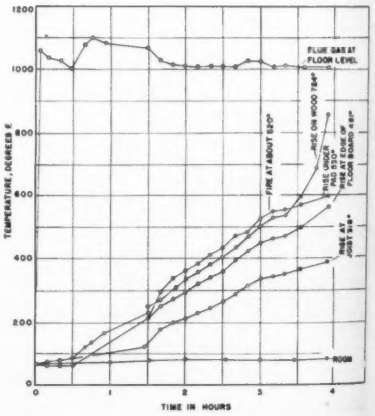


Fig. 5. Temperatures developed with an unlined brick chimney by a gas-fired burner.

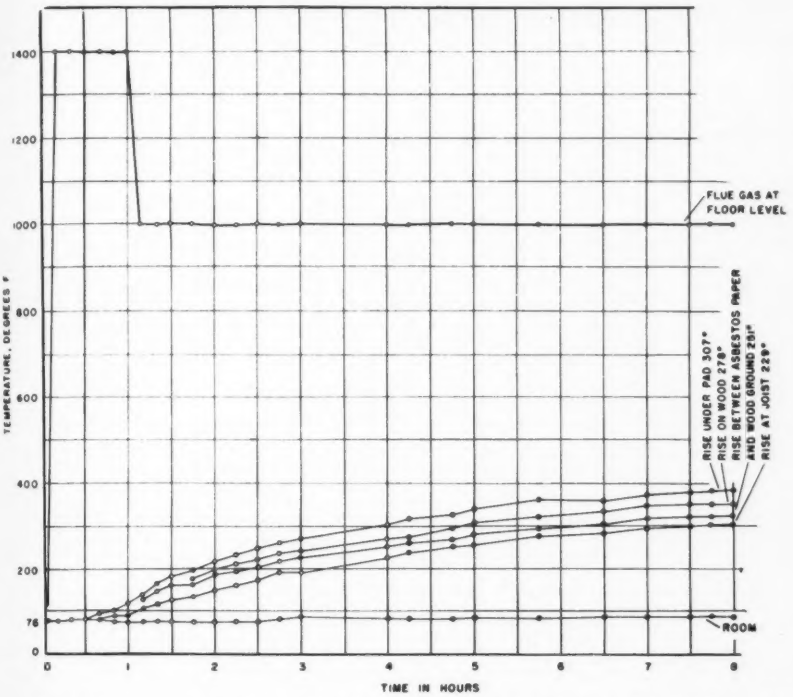


Fig. 6. Temperatures developed with a lined brick chimney by a gas-fired burner. Flue gas at the floor level at 1400°F for 1 hour and 1000°F thereafter (1400/1000).

on the sides of the wooden joists at 2 in. from the chimney, from 62° to 326°F. In some of the tests the edges of floor boards touched the masonry with consequent rises of 132° to 363°F at these places. Figure 3 shows temperatures resulting from extremely high fires in the No. 20 Cannon stove in test No. 28A with an 8- by 12-in. lined chimney.

Two chimneys constructed of concrete chimney units with integral liners cracked through both shell and liner when subjected to test with wood-fired stoves. One of these was of cinder concrete; the other had sand as the concrete aggregate. No further tests were made on these. Previous experience with this type of unit had indicated that it was subject to cracking under minor heat shock and would ignite combustibles in contact with its surface if exposed to flue gases having moderately high temperatures. (See cut page 124.)

Gas Fires.—There were 141 tests (88 tests shown in Tables I and II) made with gas fires. The temperature of the flue gas measured at the level of the floor framing in 58 of these was constant, or nearly so at temperatures ranging from 600° to 1300°F and for periods of 4 to 14 hours. The temperatures for tests on the 8- by

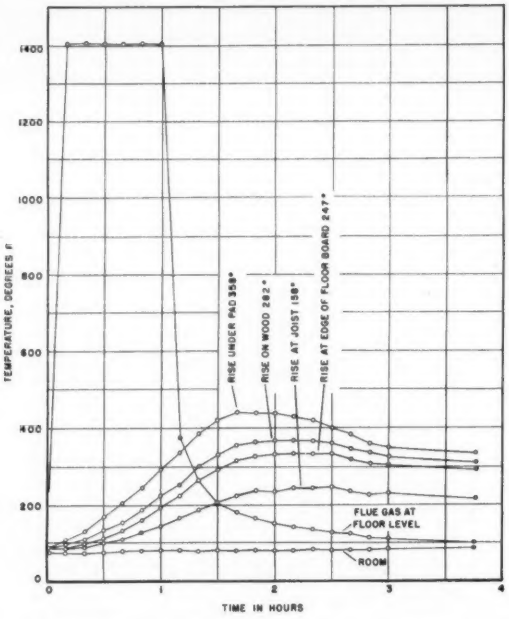


Fig. 7. Temperatures developed with an unlined brick chimney by a gas-fired burner. Flue gas at the floor level at 1400° F.

8-in. lined and unlined brick chimneys, Nos. 1 and 2, with flue gas temperatures at about 1000°F are shown in Figures 4 and 5. Another procedure used was to subject the chimney to flue gas temperatures held at 1400°F for the first hour, after which the temperature was held at 1000°F for the rest of the test period as shown in Figure 6. Sixty-two such tests were applied to 17 of the chimneys. Four somewhat similar tests were made wherein the flue gas temperature was held at 1000° F for 7 to 11 hours followed by a 1-hr. period with the flue gas at 1400°F. Temperatures of the surface of the chimney and of the surrounding woodwork were considerably higher at the end of these tests than were observed when the 1400° to 1000° schedule of test was followed. Figure 7 shows the temperatures by a gas fire in an unlined brick chimney in which the flue gas temperature was maintained at 1400°F for one hour.

Temperature rises on the surfaces of the chimneys in the constant flue gas temperature tests ranged from 141°F to 551°F, on the plaster grounds from 101°F to 784°F, and on the side of the joist 2 in. from the chimney surface, 108°F to 322°F. Corresponding temperature rises on the surface of the chimney, the ground strip, and the side of the joist when the flue gases were held at 1400°F for 1 hr. and then at 1000°F thereafter ranged from 142°F to 677°F on the surface, from 193°F to 583°F on the ground strip, and from 103°F to 392°F on the side of the joist. In 23 tests evidence of

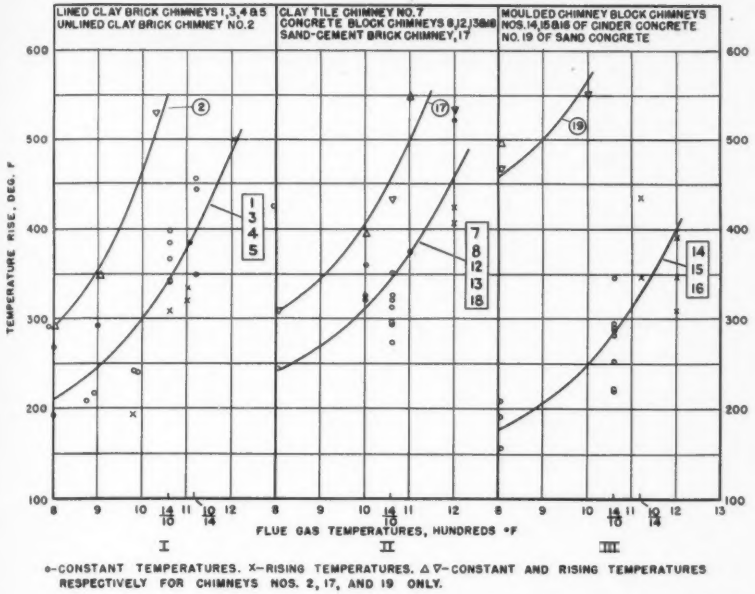
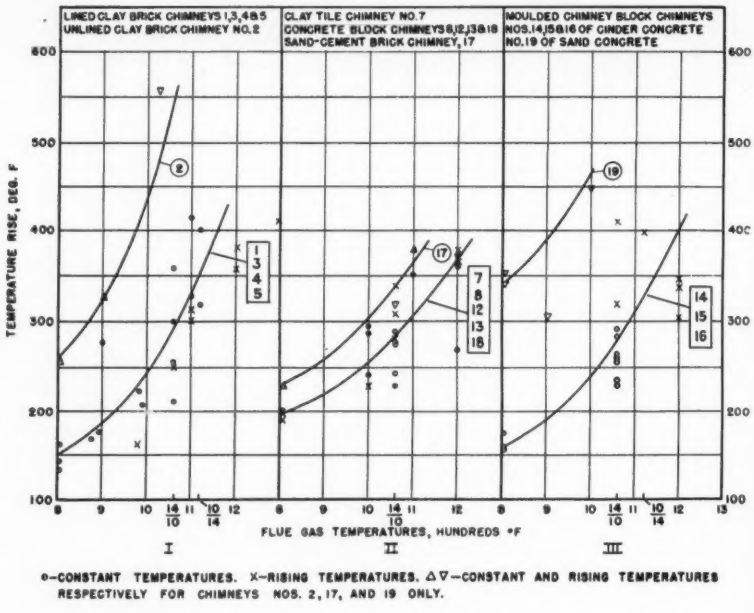

LINED CLAY BRICK CHIMNEYS 1,3,4 & 5
UNLINED CLAY BRICK CHIMNEY NO.2
CLAY TILE CHIMNEY NO.7
CONCRETE BLOCK CHIMNEYS 8,12,13&18
SAND-CEMENT BRICK CHIMNEY,17
MOULDED CHIMNEY BLOCK CHIMNEYS
NOS.14,15&16 OF CINDER CONCRETE
NO. 19 OF SAND CONCRETE
TEMPERATURE RISE, DEG. F
FLUE GAS TEMPERATURES, HUNDREDS °F
I
II
III
o-CONSTANT TEMPERATURES. X-RISING TEMPERATURES. Δ ∇-CONSTANT AND RISING TEMPERATURES RESPECTIVELY FOR CHIMNEYS NOS. 2, 17, AND 19 ONLY.

Fig. 8. Comparative rise of temperature on chimney surface at level of floor framing in relation to flue gas temperature at the same level.

ignition of adjacent woodwork was observed, and in several other instances the temperatures measured were within the range of those measured in these tests in which ignition had occurred. Several hours after the end of a test with flue gas temperature held at 1100°F for 11 hr. 40 min., the combustible framing of the test structure burned.

Summary

Three aspects of the fire hazards from the chimneys tested are summarized in Figures 8, 9 and 10. Figure 8 gives graphic representation of the rise of temperatures under 6- by 6-in. by 0.4-in. thick felted asbestos pads applied to the surfaces of the chimneys at the level of the floor joist opposite the station where the flue gas temperatures were measured. The curves show the trend of increasing rise of the chimney surface temperature with increase of prevailing flue gas temperatures. The second of these, Figure 9, points to a prevalent condition from which many fires are thought to originate, that is, overheating of wood plaster grounds or wood trim or other combustibles in contact with chimney faces. As shown in Figure 9, the lines indicating the trends of average measured rises of temperatures on wood in contact with the chimney turn sharply upward with increase in the prevailing flue gas temperatures at the point opposite. Figure 10 shows the temperature rises measured on the sides of the floor joists spaced 2 in. from the surface of the chimney. The upward curvature of the lines with increase of flue gas temperature is apparent here also. Fills of mineral wool between the


LINED CLAY BRICK CHIMNEYS 1,3,4&5
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MOULDED CHIMNEY BLOCK CHIMNEYS NOS.14,15&16 OF CINDER CONCRETE
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TEMPERATURE RISE, DEG. F
FLUE GAS TEMPERATURES, HUNDREDS °F
I
II
III
o—CONSTANT TEMPERATURES. X—RISING TEMPERATURES. Δ∇—CONSTANT AND RISING TEMPERATURES RESPECTIVELY FOR CHIMNEYS NOS. 2, 17, AND 19 ONLY.

Fig. 9. Comparative rise of temperature on wood grounds in contact with the chimney surface in relation to flue gas temperature at the same level.

chimney and joists as shown at the left of Figure 11 resulted in ignition of the woodwork in several of the tests.

Conclusion

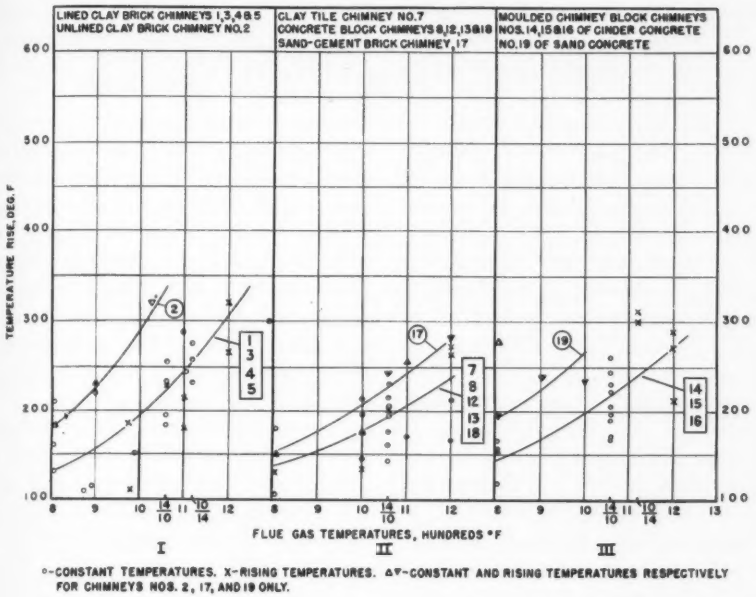
The report provides evidence from which certain tentative conclusions may be drawn. Some of these are:

1. Chimneys safe from the standpoint of fire may be constructed with walls of burned clay or shale, certain kinds of structural tiles, of cinder concrete structural units, or cinder concrete chimney blocks if proper structural details are used, precautions taken with respect to contacts with combustible materials, and the flues are provided with suitable liners.

2. Unlined chimneys present greater hazards from fire than do lined ones. Liners of burned fire clay withstand heat shock better than those of burned surface clay. Liners should be installed with only sufficient mortar to make up a good joint and stay them in position within the chimney, particularly if the heat shock is likely to be severe; otherwise continuous cracks through liner and flue wall are liable to develop. Round liners have some advantages over the rectangular ones.

Expansion of concrete liners cast integrally with concrete chimney units caused the outer shell of the unit to crack and the liners were cracked in turn on cooling, thus developing cracks through both the liner and the masonry wall.

3. The space between the chimney wall and the wood framing adjacent should have noncombustible fire-stopping at the


LINED CLAY BRICK CHIMNEYS 1,3,4&5
UNLINED CLAY BRICK CHIMNEY NO.2
CLAY TILE CHIMNEY NO.7
CONCRETE BLOCK CHIMNEYS 8,12,13&18
SAND-CEMENT BRICK CHIMNEY, 17
MOULDED CHIMNEY BLOCK CHIMNEYS
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TEMPERATURE RISE, DEG. F
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I
II
III
○-CONSTANT TEMPERATURES. X-RISING TEMPERATURES. △▽-CONSTANT AND RISING TEMPERATURES RESPECTIVELY FOR CHIMNEYS NOS. 2, 17, AND 19 ONLY.

Fig. 10. Comparative rise of temperature on side of wood joist 2 inches from chimney in relation to flue gas temperature at the same level.

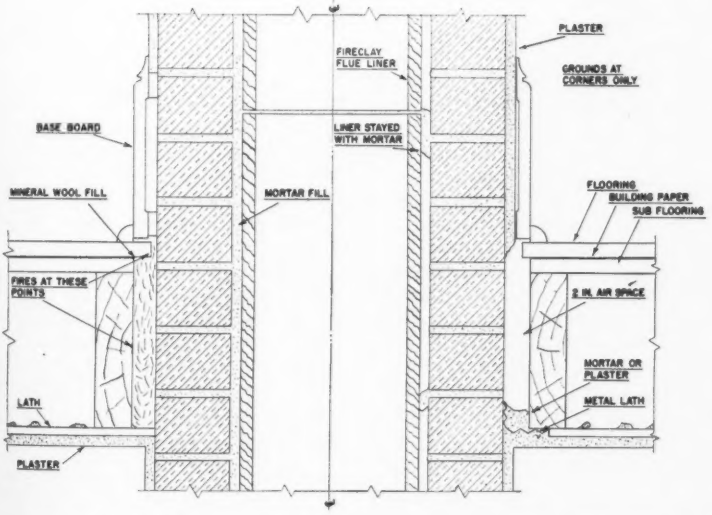


Fig. 11. Section of chimney at first floor. Fills of mineral wool at the left resulted in ignition of the woodwork in several tests.

bottom, and should otherwise be left unfilled so that heat can be dissipated by convection air currents as illustrated on the right side of the chimney in Figure 11.

4. If the chimney needs to be stayed at the floor or roof level, contact of floor or sheathing boards for the purpose should be limited to not more than 1½ in. each way from the corners.

5. Wooden plaster grounds or screeds should be removed after the plaster has been laid on. Metal grounds should be limited to corner locations. Nailing to the brickwork, if allowed, should also be limited to locations near the chimney's corners.

6. Baseboards and other wood trim should be applied so as to have contact with the plaster near the corners of the chimney only. A very narrow space between the plaster and the woodwork will provide for the dissipation of much of th heat coming to the surface of the plaste

7. The tests reported have not covere the subject in sufficient detail to affor answers to several important question Among these are such questions as – How hot may the surface of the chimne become without igniting combustible ma terials in contact therewith? What is th ignition temperature of wood exposed t repeated heating and cooling at the chim ney surface? How can the firing of heat ing devices be regulated or the drafts con trolled so that excessive flue gas tempera tures will not be developed?

Further investigation to determine an swers to these and other questions appear to be needed. Then, perhaps a more de tailed and satisfactory answer can be devel oped to answer the question, "What is a safe chimney?"

ICE CREAM CONES AND CHIMNEYS

If the children of Los Angeles experienced difficulty in obtaining ice cream cones last summer they should be told that a defective chimney was responsible at least in part for this crisis. At 1:00 A.M., July 15, 1949, the janitor of the Krispy Kake Kone Company crammed the plant's indoor incinerator with rubbish, waited around a reasonable time for the fire to burn out, then locked up and went home. Two and a half hours later firemen were battling a raging fire in the one-story brick, wood-joisted building. Before being subdued, flames destroyed the roof and contents, including cone making machinery — all because of cracks in the incinerator chimney through which heat passed to ignite roof joists.

Fires and Fire Losses Classified, 1948

There were approximately 570,000 building fires in the United States in 1948 causing $714,800,000 damage, according to estimates compiled by the National Fire Protection Association. An additional $1,147,000 fires not involving buildings—aircraft, motor vehicle, forest, ship, rubbish, grass fires, etc. — accounted for an estimated $61,462,000 loss, and increased the number of fires of all types in the United States in 1948 to 1,717,400. The total loss was approximately $776,000,000. Building fire estimates for 1947 reported in October 1948 *Quarterly*, showed 538,000 fires with loss of $703,000,000. Despite the 1948 increase in building fire loss there is close agreement between the over-all estimates of damage in 1947 and 1948, accounted for by the substantial decrease in the 1948 forest fire loss.

The data from which Tables I to IV were compiled were obtained from seventeen state fire marshals' reports for the year 1948 or the closest fiscal year thereto. Reports of these particular states are chosen because they contained the most complete classifications of cause and occupancy data. While the methods of reporting and tabulating fire loss figures differ from state to state, the volume of statistics from these seventeen typical states, representing all sections of the country, and including both primarily agricultural and industrial states, is sufficiently large to indicate the relative distribution of fires and fire losses. Table I shows the number of fires by occupancy in sixteen states and Table II the loss by occupancy in fourteen states. Tables III and IV list the number of fires and loss by cause in seventeen and fourteen states respectively. Table V summarizes loss statistics of all states that have furnished data to the NFPA.

Tables VI and VII, showing the nationwide distribution of fires and losses by occupancy and causes, are based primarily on typical state experience enumerated in Tables I to IV. Since the value of Table VI increases as the number of items reported is expanded, new classifications have been added from year to year whenever available data permitted. This year fires in boarding and rooming houses have been separated from those in hotels and apartments and reported as a new item "Boarding and Rooming Houses." The large proportion of states now reporting filling station experience permitted separation of this item from garages in the 1948 reports. Various sources have furnished figures for the individual items in Group VI. Statistics on aircraft fires were compiled by the NFPA Committee on Aviation and Airport Fire Protection. Motor vehicle data are based on a recent survey of 485 U. S. cities (Fire Record of Cities, April 1948 *Quarterly*). Forest fire estimates are those compiled and published by the Forest Service of the U. S. Department of Agriculture. Results of the recent survey of U. S. cities were also the basis for an estimate of the number of rubbish, grass and brush fires. The 7 per cent increase over 1947 in the number of fires in this classification is a conservative estimate. Many communities reported increases in the neighborhood of 50 per cent in rubbish, grass and brush fires.

As will be seen in Table V, the seventeen states with a population of 48,638,000 reported a total of 163,490 fires. Experience indicates that this is somewhat under

Table I. Number of Fires by Occupancies in Sixteen States — 1948

Occupancies	Connecticut[1]	Illinois	Iowa	Kansas	Louisiana	Massachusetts[2]	Nebraska	New Hampshire[3]	North Dakota[1]	Ohio	Oklahoma	Oregon[4]	South Dakota[5]	Vermont[3,4]	West Virginia	Wisconsin	Totals
I. PUBLIC BUILDING																	
Government buildings	1	3	....	4	33*d*	13	1	2	8*d*	....	....	22	....	2	6	7	102
Hospitals, institutions	....	17	17	5	....	14	3	1	....	23	1	....	2	3	2	37	125
Schools and colleges	12	77	22	11	47	36	14	3	5	60	1	38	7	6	9	90	438
Churches	10	87	33	14	21	29	17	3	15	80	48	48	6	6	6	83	506
Theatres, including motion pictures	....	27	11	10	30	11	5	2	4	28	3	20	5	1	4	32	193
Amusements, halls	13	77	31	11	....	80	....	7	....	108	....	....	8	9	2	124	470
II. DWELLINGS																	
Hotels	13	339*a*	45	31	....	29	22	7	49*g*	215*a*	200*m*	505*a*	32*m*	9	7	143	1,646
Boarding and rooming houses	36	....	18	11	449*e*	68	....	14	....	....	112	....	4	4	2	65	783
Apartments	137	2,628	204	100	....	223	75	92	....	1,610	....	....	24	....	34	227	5,354
Dwellings	911	5,264	1,829	1,313	2,981	4,323	708	386	468*h*	8,328	1,606	8,277*h*	433	628*h*	381	15,385	53,221
III. MERCANTILE																	
Offices and multiple mercantiles	24	138	64	34	....	60	20	....	....	877	111	....	13	1	6	71	1,419
Restaurants, taverns	51	481	112	221	....	120	42	11	....	....	....	180	9	10	17	536	1,790
Miscellaneous mercantiles	133	1,376	236	199	276	336	124	76	122	1,246	419	585*j*	103*l*	100	66	637	6,034
Warehouses	36	130	121	58	54	109	63	7	19	293	140	18	....	3	8	180	1,239
IV. MANUFACTURING																	
Metal workers	11	55	45	20	4	32	....	2	5	....	....	41	1	2	....	80	298
Woodworkers	4	6	20	8	50	11	....	13	1	....	....	146	....	15	5	12	291
Flour mills, elevators	....	27	17	13	13	....	13	....	20	....	....	20	16	....	....	27	166
Packing plants	....	13	20	8	....	38	3	....	....	....	....	24	1	2	....	9	118
Bakeries	4	36	7	6	....	9	2	....	....	....	....	16	....	1	....	22	103
Textile workers	2	....	....	1	51	12	....	....	....	....	4	6	....	3	....	8	87
Printing	2	....	7	8	....	11	....	....	....	....	....	13	....	1	....	13	55
Laundries	7	49	9	24	....	20	1	2	3	35	....	45	4	2	....	16	217
Cleaners, tailors	10	55	16	....	....	20	....	6	....	37	315	....	3	1	4	26	493
Miscellaneous manufacturing	64	623	61	14	348	248	41	18	5	966	114	44	9	17	22	435	3,029
V. MISCELLANEOUS																	
Barns	134	273	146	329*c*	154*f*	118	193	34	331	439	205	238	95	437*c*	6	541	3,673
Outbuildings	....	1,121	79	....	....	121	56	41	....	603	461	12	18	....	6	1,129	3,647
Lumber and coal yards	6	25	69	4	24	22	....	1	3	49	2	....	2	1	....	30	238
Piers, including shipyards	....	27	....	....	....	1	....	....	....	....	....	....	....	....	....	....	28
Railroad property, inc. rolling stock	....	133	20	10	20	9	18	2	....	....	....	....	6	1	2	119	340
Bulk oil storage, refineries	1	21	....	6	56	....	1	....	9	....	....	27	3	....	....	....	124
Garages	123	1,174	273	56	34	221	157	29	35	1,250*i*	264	69	64*i*	15	29	453	4,246
Filling stations	17	106	28*b*	41	....	35	29	2	....	....	81	....	....	7	2	59	407
Power plants, pump houses	5	15	16	2	....	17	15	....	....	....	....	24	10	2	....	74	180
Creameries and dairies	....	....	3	3	....	....	8	....	11	....	....	9	3	1	....	52	90
Miscellaneous structures	89	576	176	8	137	75	....	18	16	1,094	2,306	58	1	....	11	54	4,619
Hangars and contents	....	4	....	....	....	....	....	....	....	....	....	....	1	1	....	5	11
VI. OTHER THAN BUILDING FIRES																	
Aircraft	....	4	....	3	....	3	....	1	....	....	....	....	....	....	....	1	12
Motor vehicles	222	3,171	787	450	398	665	304	....	....	4,859	426	436	150	....	44	2,290	14,202
Watercraft	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Forest fires	....	....	....	....	....	....	71	....	....	....	953	....	....	....	....	....	1,024
Rubbish, grass, brush	6	208	16	1	....	....	5	....	....	....	....	....	40	1	....	50	327
Miscellaneous	5	13	....	....	....	11	....	....	....	....	....	....	....	....	....	9	38
Total	2,089	18,379	4,558	3,037	5,180	7,150	2,011	780	1,129	22,200	7,772	10,921	1,073	1,292	681*k*	23,131	101,383

[1]Fiscal year ends June 30, 1948.
[2]Does not include Boston.
[3]No losses less than $50.
[4]Insured claims only.
[5]Fiscal year ends June 30, 1949.

a. Inc. boarding and rooming houses.
b. Inc. bulk oil storage.
c. Inc. rural dwellings, outbuildings.
d. Inc. hospitals, institutions.
e. Inc. hotels, clubs.
f. Inc. all farm property.
g. Inc. clubs, gymnasiums.
h. Inc. apartments.
i. Inc. filling stations.
j. Inc. offices.
k. Inc. 59 duplicates.
l. Inc. warehouses.
m. Inc. restaurants.

Miscellaneous	5	13	....	....	....	11	....	....	....	....	....	....	....	....	9	38
Total	2,089	18,379	4,558	3,037	5,180	7,150	2,011	780	1,129	22,200	7,772	10,921	1,073	1,292	681*k*	23,131	101,383

[1]Fiscal year ends June 30, 1948.
[2]Does not include Boston.
[3]No losses less than $50.
[4]Insured claims only.

[5]Fiscal year ends June 30, 1949.
a. Inc. boarding and rooming houses.
b. Inc. bulk oil storage.
c. Inc. rural dwellings, outbuildings.
d. Inc. hospitals, institutions.
e. Inc. hotels, clubs.
f. Inc. all farm property.
g. Inc. clubs, gymnasiums.
h. Inc. apartments.
i. Inc. filling stations.
j. Inc. offices.
k. Inc. 59 duplicates.
l. Inc. warehouses.
m. Inc. restaurants.

Table II. Fire Losses by Occupancies in Fourteen States — 1948

Occupancies	Connecticut[1]	Illinois[2]	Iowa	Kansas	Louisiana	Massachusetts[3]	Nebraska	North Dakota[4]	Ohio	Oregon[4]	South Dakota[4]	Vermont[4,5]	West Virginia	Wisconsin	Totals
I. Public Buildings															
Government buildings	$22,123	$6,058	.....	$24,835	$36,597*d*	$16,065	$150	$4,103*d*	.....	$12,531	.....	$10,126	$23,070	$5,641	$161,299
Hospitals, institutions	.....	34,830	$166,170	3,214	.....	91,563	949	.....	$65,950	.....	$713	50,886	600	100,694	515,569
Schools and colleges	126,522	817,902	137,782	107,465	198,663	583,271	62,262	276	94,318	167,940	29,181	29,394	91,000	235,432	2,681,408
Churches	51,775	440,543	199,809	53,378	19,923	383,601	144,692	6,402	241,505	125,477	29,068	2,872	34,175	159,974	1,933,194
Theatres, including motion pictures	.....	157,595	38,720	40,248	52,659	9,541	52,770	2,239	45,071	68,634	33,485	340	18,350	29,191	548,883
Amusements, halls	56,623	327,876	534,621	65,065	.....	496,703	.....	.....	1,525,827	.....	23,330	15,420	4,000	387,235	3,436,700
II. Dwellings															
Hotels	9,765	99,003*a*	17,801	161,792	.....	193,648	16,723	85,518*g*	64,971*a*	237,696*a*	62,250*l*	63,527	14,829	202,253	1,229,776
Boarding and rooming houses	16,424	.....	19,335	4,377	697,840*c*	48,830	.....	.....	.....	.....	1,704	484	5,100	34,395	828,489
Apartments	236,335	268,791	248,795	50,633	.....	532,755	71,495	.....	818,749	.....	5,048	.....	51,635	81,709	2,365,945
Dwellings	1,460,082	3,881,097	1,804,589	733,394	2,019,675	4,868,961	718,332	255,858*h*	5,339,104	3,083,223	347,860	396,331*h*	925,879	4,788,828	30,623,213
III. Mercantile															
Offices and multiple mercantiles	98,603	858,169	331,364	27,383	.....	447,338	46,263	.....	1,875,221	.....	7,991	1,056	6,400	48,057	3,747,845
Restaurants, taverns	132,303	757,084	200,082	1,028,060	.....	445,053	184,092	.....	.....	209,547	17,558	3,439	113,444	446,576	3,537,238
Miscellaneous mercantiles	727,840	2,868,624	1,319,664	584,299	487,461	1,452,363	1,044,023	233,599	1,447,385	998,327*j*	905,098*k*	223,067	729,244	1,657,289	14,678,683
Warehouses	386,220	474,614	798,391	277,887	371,697	1,162,694	319,302	58,798	1,971,606	56,732	.....	17,421	7,525	981,621	6,884,508
IV. Manufacturing															
Metal workers	35,935	56,420	166,166	92,950	36,846	187,423	.....	5,451	.....	844,856	17,000	1,682	.....	712,231	2,156,960
Woodworkers	64,120	5,230	14,970	247,714	320,004	48,754	.....	2,000	.....	1,622,212	449,950	90,807	45,775	43,085	2,954,621
Flour mills, elevators	.....	632,769	280,744	206,878	114,015	.....	217,295	160,172	.....	113,621	422	.....	.....	127,111	1,853,027
Packing plants	.....	3,637	79,866	49,502	.....	336,965	48,705	.....	.....	117,415	.....	52,396	.....	817	689,303
Bakeries	2,700	117,700	6,940	3,612	.....	16,605	203	.....	.....	1,633	.....	1,146	.....	12,620	163,159
Textile workers	3,249	.....	.....	225	139,483	142,827	.....	.....	.....	1,721	.....	1,052	.....	2,916	291,473
Printing	4,060	.....	78,650	16,747	.....	14,778	.....	.....	.....	9,605	.....	289	.....	4,034	128,163
Laundries	10,592	107,502	28,515	10,159	.....	24,639	37,250	785	132,751	35,208	1,413	629	.....	23,119	412,562
Cleaners, tailors	39,937	15,255	14,937	.....	.....	13,246	.....	.....	72,830	.....	28,533	1,381	1,920	8,854	196,893
Miscellaneous manufacturing	362,969	1,803,762	801,571	22,263	693,830	2,373,535	585,203	4,728	6,220,918	54,043	22,787	27,830	307,325	2,695,145	15,975,909
V. Miscellaneous															
Barns	569,098	1,057,319	613,694	865,078*c*	200,198*f*	397,475	462,419	279,454	1,645,513	356,389	164,287	960,464*c*	25,800	1,569,134	9,166,322
Outbuildings	.....	306,074	108,890	.....	.....	92,190	29,371	.....	319,412	95,548	7,766	.....	6,755	259,487	1,225,493
Lumber and coal yards	725,950	385,146	177,561	80,585	21,605	63,617	.....	4,873	167,719	.....	58,000	588	.....	177,940	1,863,584
Piers, including shipyards	.....	.....	.....	.....	.....	89	.....	.....	.....	.....	.....	.....	.....	.....	89
Railroad property, inc. rolling stock	.....	82,226	47,153	5,025	19,831	5,061	33,457	.....	.....	.....	894	6,658	1,000	56,496	257,801
Bulk oil storage, refineries	175	470,035	.....	43,110	207,328	.....	2,160	129,836	.....	26,446	5,940	.....	.....	.....	885,030
Garages	189,921	1,022,295	416,951	242,691	65,141	378,868	344,950	1,545	895,637*i*	87,984	144,321*i*	32,168	164,976	498,725	4,486,173
Filling stations	26,475	47,484	20,178*b*	71,629	.....	39,896	27,478	.....	.....	.....	.....	7,756	23,000	37,099	300,995
Power plants, pump houses	3,265	60,975	10,675	1,040	.....	824,349	220,070	.....	.....	206,111	10,910	2,072	.....	58,455	1,397,922
Creameries and dairies	.....	.....	1,820	10,300	.....	.....	2,089	97,462	.....	15,811	18,150	32,569	.....	114,323	292,524
Miscellaneous structures	239,739	728,041	262,163	3,465	720,991	229,802	.....	21,844	1,912,762	238,908	1,000	.....	145,530	26,168	4,530,413
Hangars and contents	.....	84,000	.....	.....	.....	.....	.....	.....	.....	.....	26,000	59	.....	5,962	116,021
VI. Other Than Building Fires															
Aircraft	.....	8,350	.....	16,500	.....	12,214	.....	.....	.....	.....	.....	.....	.....	501	37,565
Motor vehicles	76,151	438,669	91,683	75,828	56,062	124,314	135,370	.....	623,315	97,683	35,338	.....	33,460	343,147	2,131,020
Watercraft	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Forest fires	.....	.....	.....	.....	.....	.....	7,595	.....	.....	.....	.....	.....	.....	.....	7,595
Rubbish, grass, brush	6,335	24,111	10,127	15	.....	.....	2,125	.....	.....	.....	8,112	2,955	.....	18,954	72,734
Miscellaneous	24,500	8,525	.....	.....	.....	9,300	.....	.....	.....	.....	.....	.....	.....	1,845	44,170
Total	$5,709,786	$18,457,711	$9,050,377	$5,227,346	$6,479,849	$16,068,333	$4,816,793	$1,355,343	$25,480,564	$8,885,301	$2,464,109	$2,036,864	$2,780,832	$15,997,063	$124,810,271

[1]Fiscal year ends June 30, 1948.
[2]Does not include Chicago.
[3]Does not include Boston.
[4]Insured losses only.
[5]Does not include fires with loss less than $50.
[6]Fiscal year ends June 30, 1949.

a. Includes boarding and rooming houses.
b. Includes bulk oil storage.
c. Includes rural dwellings, outbuildings.
d. Includes hospitals, institutions.
e. Includes hotels, clubs.
f. Includes all farm property.
g. Includes clubs, gymnasiums.
h. Includes apartments.
i. Includes filling stations.
j. Includes offices.
k. Includes warehouses.
l. Includes restaurants.

Table III. Number of Fires by Causes in Seventeen States — 1948

Causes	Connecticut[1]	Illinois	Iowa	Kansas	Louisiana	Massachusetts[2]	Michigan	Nebraska	New Hampshire[3]	North Dakota[1]	Ohio	Oklahoma	Oregon[4]	South Dakota[1]	Vermont[3,4]	West Virginia	Wisconsin	Totals
Chimneys, flues, defective or overheated	131	914	244	141	114	435	2,348	90	125	63	975	90	771	55	112	51	1,309	7,968
Sparks on roof	29	701	372	46	22	69	2,850	....	....	11	....	....	298	....	4	....	777	5,179
Defective or overheated heating equipment	208	1,558*a*	346	138*a*	668*a*	498	4,317	178	108	116*a*	2,131*a*	562	1,758*a*	144	117*a*	70	2,467	15,384
Rubbish	186	2,105	34	29	83	....	2,020	187	25	9	1,221	3,594	61	56	7	....	110	9,727
Combustibles near heaters	3	....	13	....	....	228	....	....	....	....	....	....	....	....	....	5	360	609
Open lights, flames, sparks	98	375	310	87	195	237	13,441	128	7	21	1,740	....	170	80	23	16	954	17,882
Hot ashes, coals	17	273	45	195	120	75	376	21	2	10	153	310	687	18	20	....	212	2,537
Smoking and matches	282	3,489	499	284	788	1,956	3,345	220	110	163	3,780	....	2,923	126	173	51	4,591	22,780
Children and matches	53	....	131	....	....	362	1,790	58	18	....	768	146	....	44	....	17	368	3,755
Electrical, fixed service, fires due to misuse, or faulty wiring and equipment	236	3,388	544	427	580	779	2,472	230	64	98	3,996	131	952	121	98	86	2,208	16,410
Electrical power consuming appliances	105	176	252	30	147	359	1,510	48	34	13	512	155	501*c*	34	11	....	1,273	5,160
Flammable liquids, misc. including home dry cleaning and starting fire with	54	1,020	250	241	228	454	317	58	8	74	1,506	250	188	20	150	20	155	4,993
Torches, welding, cutting, plumbers, etc.	30	....	76	....	....	100	....	18	4	....	167	....	....	16	....	8	87	506
Lamps, lanterns, oil stoves	77	....	178	....	....	508	810	12	103	....	....	120	....	72	....	10	696	2,586
Gas and explosions	....	122	51	68	120	21	....	84	....	17	174	88	....	24	3	30	150	952
Grease, tar, etc.	19	200	47	38	79	165	....	....	20	32	263	....	726	....	12	10	717	2,328
Spontaneous ignition	39	388	80	4	35	271	512	116	23	24	365	191	100	23	20	5	254	2,450
Lightning	68	240	89	89	169	215	....	56	16	126	241	15	36	26	79	14	4,239	5,718
Thawing pipes	6	....	18	....	....	29	293	....	4	....	....	....	....	....	....	3	29	382
Sparks from machinery, friction	....	71	21	6	119	17	....	....	....	9	....	....	86	5	24	....	52	410
Incendiary, suspicious	27	74	10	8	24	107	204	11	10	2	205	....	50	5	21	19	65	842
Miscellaneous	142	1,117	133	160	120	45	12,229	21	25	21	1,776	1,465	41	49	21	18	42	17,425
Unknown	237	1,460	519	849	1,188	192	3,074	238	21	185	1,776	655	1,201	97	306	147	939	13,084
Explosions	29	155	74	70	62	28	258	111	13	59	....	....	133*d*	36	8	1	616	1,653
Exposure	13	553	222	127	319	110*b*	....	126	40	76	451	....	239	22	83	41	461	2,773
Totals	2,089	18,379	4,558	3,037	5,180	7,150	52,166	2,011	780	1,129	22,200	7,772	10,921	1,073	1,292	622	23,131	163,490

[1]Fiscal year ends June 30, 1948.
[2]Does not include Boston.
[3]Does not include fires with loss less than $50.
[4]Insured claims only.
[5]Fiscal year ends June 30, 1949.
a. Includes oil stoves.
b. Not included in totals.
c. Includes hot metals.
d. Includes sparks from combustion.
e. Includes sparks on roofs, from machinery, friction.

[1]Fiscal year ends June 30, 1948.
[2]Does not include Boston.
[3]Does not include fires with loss less than $50.
[4]Insured claims only.

a. Includes oil stoves.
b. Not included in totals.

d. Includes sparks from combustion.
e. Includes sparks on roofs, from machinery, friction.

Table IV. Fire Losses by Causes in Fourteen States — 1948

Causes	Connecticut[1]	Illinois[2]	Iowa	Kansas	Louisiana	Massachusetts[3]	Nebraska	North Dakota[1]	Ohio	Oregon[4]	South Dakota[4]	Vermont[4,5]	West Virginia	Wisconsin	Totals
Chimneys, flues, defective or overheated	$246,774	$599,829	$325,639	$134,393	$57,512[7]	$605,886	$77,840	$42,169	$1,328,826	$481,731	$69,808	$75,268	$171,308	$684,290	$4,901,273
Sparks on roof	50,429	341,724	293,005	10,003	21,733	138,732	.....	7,820	.....	191,314	.....	8,146	.....	588,613	1,651,519
Defective or overheated heating equipment	636,590	1,369,977*a*	766,097	110,941*a*	579,911*a*	924,280	585,828	84,157*a*	1,963,740*a*	1,143,571	233,443	90,008*a*	221,026	1,305,855	10,015,424
Rubbish	323,253	138,491	20,686	24,887	113,287	.....	157,595	3,890	389,770	21,246	24,046	1,146	.....	40,148	1,268,445
Combustibles near heaters	8,800	.....	1,504	.....	.....	456,314	.....	.....	.....	.....	.....	.....	18,550	101,832	587,000
Open lights, flames, sparks	77,893	495,940	191,108	126,625	189,071	258,943	200,560	14,145	1,089,922	619,128	22,710	27,960	18,638	736,264	4,068,907
Hot ashes, coals	42,020	88,516	28,423	67,037	48,928	59,858	11,732	1,070	116,966	153,132	9,375	14,541	.....	70,976	712,574
Smoking and matches	307,859	471,670	372,668	84,472	452,606	3,136,723	113,367	55,524	1,800,298	720,688	38,622	99,712	80,945	1,002,082	8,737,236
Children and matches	236,880	.....	50,113	.....	.....	263,090	19,911	.....	209,474	.....	30,805	.....	6,329	152,323	968,925
Electrical, fixed service, fires due to misuse or faulty wiring and equipment	385,349	1,835,998	480,415	247,790	392,870	3,554,262	270,631	155,782	2,554,095	1,075,552	304,262	219,716	204,640	3,728,573	15,409,935
Electrical power consuming appliances	111,956	38,601	333,130	8,936	85,211	81,627	160,794	20,325	187,180	115,514*c*	110,331	2,780	.....	791,835	2,048,220
Flammable liquids, misc. including home dry cleaning and starting fires with	67,883	1,139,545	163,320	241,690	217,210	1,393,313	71,961	91,538	1,528,745	289,673	21,428	121,900	29,262	54,262	5,431,730
Torches, welding, cutting, plumbers, etc.	89,206	.....	229,005	.....	.....	146,596	59,590	.....	279,248	.....	79,391	.....	63,563	31,892	978,491
Lamps, lanterns, oil stoves	161,319	.....	181,955	.....	.....	656,165	5,160	.....	.....	.....	79,717	.....	28,600	464,116	1,577,032
Gas and appliances	.....	63,303	142,243	58,220	213,931	19,712	212,087	7,197	255,190	.....	12,577	2,482	111,756	54,526	1,153,224
Grease, tar, etc.	65,275	69,115	14,369	10,398	17,221	194,336	.....	8,158	372,910	139,604	.....	8,763	22,805	111,350	1,034,304
Spontaneous ignition	103,836	520,374	255,859	12,750	57,675	851,609	473,196	17,936	1,193,572	153,807	214,279	55,787	5,929	1,039,529	4,956,138
Lightning	102,092	2,017,869	580,334	341,256	85,029	336,684	241,960	64,527	745,583	52,464	82,115	52,557	24,605	1,034,926	5,762,001
Thawing pipes	5,058	.....	27,420	.....	.....	66,701	.....	.....	.....	.....	.....	.....	10,550	20,559	130,288
Sparks from machinery, friction	.....	40,152	106,149	6,741	59,174	38,190	.....	32,590	.....	113,381	3,960	86,237	.....	27,129	513,703
Incendiary, suspicious	91,485	92,211	3,894	2,976	21,143	1,035,945	2,912	86	550,749	193,109	32,464	20,500	280,975	289,016	2,617,459
Miscellaneous	204,081	384,690	141,310	172,171	189,288	164,079	235,030	10,450	2,457,536	39,370	36,819	21,565	89,011	30,636	4,176,036
Unknown	2,225,627	7,642,967	3,682,179	2,963,475	3,083,004	1,518,503	1,100,483	414,188	8,108,099	3,018,947	564,508	1,000,976	1,273,418	2,765,190	39,361,564
Explosions	111,321	230,048	58,731	381,910	283,065	166,785	456,183	48,925	.....	82,383*d*	19,954	6,033	75	380,257	2,225,670
Exposure	54,800	876,691	590,821	220,681	311,980	235,279*b*	359,973	274,866	348,661	280,687	473,495	120,787	118,847	490,884	4,523,173
Totals	$5,709,786	$18,457,711	$9,050,377	$5,227,346	$6,479,849	$16,068,333	$4,816,793	$1,355,343	$25,480,564	$8,885,301	$2,464,109	$2,036,864	$2,780,832	$15,997,063	$24,810,271

[1]Fiscal year ends June 30, 1948.
[2]Does not include Chicago.
[3]Does not include Boston.
[4]Insured losses only.
[5]Does not include fires with loss less than $50.
[6]Fiscal year ends June 30, 1949.
a. Includes oil stoves.
b. Not included in total.
c. Includes hot metals.
d. Includes sparks from combustion.
e. Includes sparks on roofs, from machinery, friction.

half the actual number of fires. Many states, for example, do not report fires with losses of less than $25 to $50. To obtain a more nearly accurate estimate of the number of fires in these seventeen states, therefore, 100 per cent is added. Making use of this figure and the population ratio, the number of building fires for the nation has been calculated.

To obtain the estimated national fire loss the population ratio was applied to the loss of the reporting states. To account for losses not reported through the usual channels, 33⅓ per cent was added as in previous years.

Table V. Fires per 1000 Population and Fire Loss per Person for Seventeen States, 1948, as Reported by Fire Marshals

State	Population 1948 Est.	No. of Fires	Fires per 1000 Pop.	Fire Loss	Fire Loss Per Person
Connecticut	1,989,000	2,089	1.05	$5,709,786[1]	$2.87
Illinois	8,348,000	18,379	2.20	18,457,711[2]	2.21[2]
Iowa	2,612,000	4,558	1.75	9,050,377	3.46
Kansas	1,895,000	3,037	1.60	5,227,346	2.76
Louisiana	2,591,000	5,180	2.00	6,479,849	2.50
Massachusetts	4,638,000	7,150	1.54	16,068,333[3]	3.46[3]
Michigan	6,216,000	52,166	8.38	29,618,534	4.78
Nebraska	1,283,000	2,011	1.57	4,816,793	3.75
New Hampshire	523,000	780[4,5]	1.49	2,861,386[4,5]	5.47[4,5]
North Dakota	582,000	1,129[4]	1.94	1,355,343[1,4]	2.35
Ohio	7,842,000	22,200	2.83	25,480,564	3.25
Oklahoma	2,295,000	7,772	3.39	1,479,046	0.64
Oregon	1,639,000	10,921	6.77	8,885,301	5.42[3]
South Dakota	611,000	1,073	1.76	2,464,109[7]	4.03
Vermont	363,000	1,292[4,5,6]	3.56	2,036,864	5.61[4,6]
West Virginia	1,911,000	622	0.33	2,780,832	1.46
Wisconsin	3,300,000	23,131	7.00	15,997,063	4.85
Total	48,638,000	163,490	3.36	$158,769,237	$3.26

[1]Fiscal year ends June 30, 1948.
[2]Chicago losses and population not included.
[3]Boston losses and population not included.
[4]Building and contents losses only.
[5]Does not include losses less than $50.
[6]Insured losses only.
[7]Fiscal year ends June 30, 1949.

States Reporting Partial Data (Not Included in Tabulations)

	Population	No. of Fires	Fire Loss	Fire Loss Per Person
Arkansas	1,937,000	10,858	$9,684,000	$5.00
Colorado	1,199,000	.....	10,174,207[2]	8.49
Delaware	300,000	.....	2,190,609[1]	7.30
Kentucky	2,856,000	.....	7,242,042[1]	2.54
Maine	898,000	4,529	10,873,135[1,2]	12.11
Montana	511,000	664	.....	...
Nevada	164,000	.....	1,816,699	11.08
New Jersey	4,768,000	.....	21,753,878	4.56
New York	14,231,000	.....	55,191,598	3.88
Rhode Island	745,000	.....	3,867,976	5.19

[1]Insured losses only.
[2]Approximately $2,000,000 incurred in 1947.

Table VI. Estimated Distribution of U. S. Fire Losses by Occupancies, 1948

These estimated figures are intended to show the relative order of magnitude of fire losses by occupancies, and while they are reasonable approximations based on the experience in typical states, they should not be taken as exact records for each class.

I. Public Buildings	No. of Fires	Losses
Government buildings	1,000	$1,500,000
Hospitals, institutions	1,100	2,000,000
Schools and colleges	2,500	11,000,000
Churches	3,000	10,400,000
Theatres, including motion pictures	1,400	5,000,000
Amusements, halls	3,300	7,500,000
II. Dwellings		
Hotels	9,000	4,000,000
Boarding and rooming houses	12,000	8,400,000
Apartments	45,000	15,000,000
Dwellings	270,000	174,000,000
III. Mercantile		
Offices and multiple mercantiles	9,000	20,000,000
Restaurants, taverns	15,000	29,000,000
Miscellaneous mercantiles	41,800	80,000,000
Warehouses	8,600	39,000,000
IV. Manufacturing		
Metal workers	2,100	14,000,000
Woodworkers	1,900	15,000,000
Flour mills, elevators	1,900	25,000,000
Packing plants	1,000	6,900,000
Bakeries	1,100	1,600,000
Textile workers	4,000	7,000,000
Printing	700	1,500,000
Laundries	1,600	3,000,000
Cleaners, tailors	2,000	3,000,000
Miscellaneous manufacturing	17,000	70,000,000
V. Miscellaneous		
Barns	22,000	39,500,000
Outbuildings	30,000	9,000,000
Lumber and coal yards	1,900	12,000,000
Piers, including shipyards	1,500	10,000,000
Railroad property, including rolling stock	5,400	8,200,000
Bulk oil storage, refineries	1,500	12,700,000
Garages	25,000	24,000,000
Filling stations	3,000	2,600,000
Power plants, pump houses	1,100	5,500,000
Creameries and dairies	900	2,500,000
Miscellaneous structures	21,600	23,000,000
Hangars and contents	100	12,000,000
Total (Building Fires)	570,000	$714,800,000
VI. Other Than Building Fires		
Aircraft	400	$13,000,000
Motor vehicles	207,000	10,000,000
Forest fires	174,000	32,462,000
Rubbish, grass, brush	738,000	.....
Miscellaneous	28,000	6,000,000
Total (Other Than Building Fires)	1,147,400	$61,462,000
Grand Total	1,717,400	$776,262,000

Note: As explained in the text, 100 per cent has been added in estimating the number of fires, and 33⅓ per cent has been added to the losses to cover unreported losses.

Railroad losses have been separated from pier and wharf property fire losses reported by State Fire Marshals. Railroad losses from Association of American Railroads report.

Table VII. Estimated Distribution of U. S. Building Fire Losses by Causes, 1948

These estimated figures are intended to show the relative order of magnitude of fire losses by occupancies, and while they are reasonable approximations based on the experience in typical states, they should not be taken as exact records for each class.

	No. of Fires	Loss
Chimneys, flues—defective or overheated	25,800	$23,000,000
Sparks on roof	23,500	16,500,000
Defective or overheated heating equipment	49,500	66,500,000
Rubbish	32,400	11,000,000
Combustibles near heaters	7,400	7,200,000
Open lights, flames, sparks	32,000	19,100,000
Hot ashes, coals	8,400	16,500,000
Smoking and matches	91,000	59,300,000
Children and matches	24,200	11,000,000
Electrical, fixed services, fires due to misuse, or faulty wiring and equipment	52,700	71,500,000
Electrical power consuming appliances	17,500	10,400,000
Flammable liquids, misc., including home dry cleaning and starting fires with	16,200	25,500,000
Torches, welding, cutting, plumbers, etc.	3,400	6,900,000
Lamps, lanterns, oil stoves	25,600	29,700,000
Gas and appliances	4,100	6,200,000
Grease, tar, etc.	10,000	6,300,000
Spontaneous ignition	8,100	23,300,000
Lightning	22,200	27,000,000
Thawing pipes	1,900	2,800,000
Sparks from machinery, friction	2,500	8,900,000
Incendiary, suspicious	5,000	12,300,000
Miscellaneous	46,000	19,700,000
Unknown	41,800	190,000,000
Explosions	6,900	23,000,000
Exposure	11,900	21,200,000
TOTAL	570,000	$714,800,000

AUTOMATIC FIRE DETECTION and ALARM SERVICE

Automatic Fire Detection and Alarm Service

Sprinkler Supervisory and Waterflow Alarm Service†

Burglar Alarm Service

Industrial Process Supervisory Service

Heating System Supervisory Service

Automatic Smoke Detection and Alarm Service

Holdup Alarm Service

Watchman's Reporting Service

Manual Fire Alarm Service

Records of large-loss fires prove conclusively that fire protection measures are not adequate unless they include dependable means for detecting and reporting fire *automatically.*

For unsprinklered properties, ADT provides Aero Automatic Fire Detection and Alarm Service. Aero is a combined pneumatic and electrical system which operates to give an alarm whenever the temperature in a protected area rises at an abnormally rapid rate.

No matter where fire may start . . . no matter what the hour of day or night . . . Aero *automatically* detects the incipient blaze and *automatically* summons fire-fighting forces.

This protection service is available through ADT Central Stations in principal cities of the United States. Elsewhere, the same protective systems, including all-important ADT inspections, tests and maintenance, may be provided for local operation or direct connection to fire or police departments.

Write for details on how ADT Services may be applied to effect better fire protection at less cost.

In addition to the prompt and efficient handling of alarms, ADT Service includes the following all-important fundamental features, without which there is little assurance that any protective signaling system will function properly when an emergency arises:

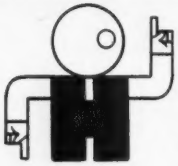
- **CONTINUOUS SUPERVISION**
- **REGULAR INSPECTIONS and TESTS**
- **COMPLETE MAINTENANCE**

ADT

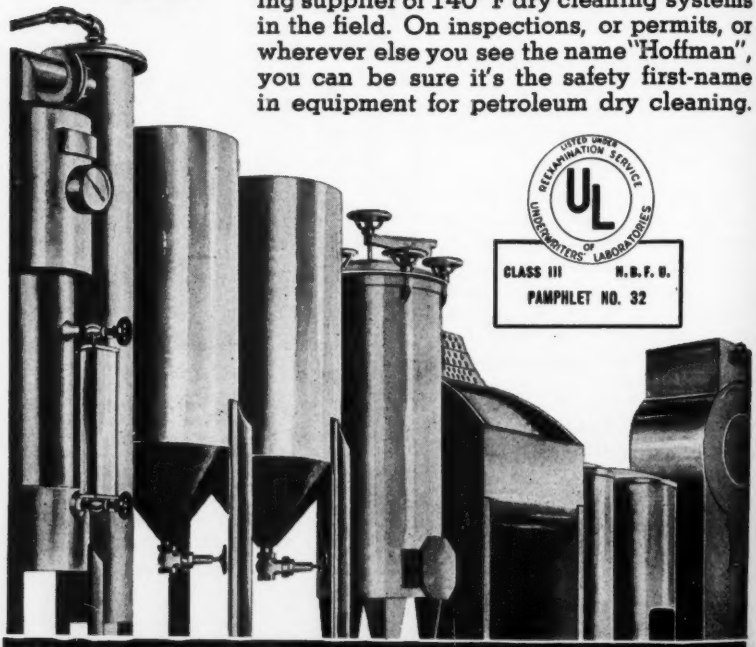
AMERICAN DISTRICT TELEGRAPH CO.
155 SIXTH AVENUE, NEW YORK 13, N. Y.
Central Stations in All Principal Cities

PROVED by a 13-Year CLEAR LOSS RECORD

HOFFMAN 140-F UNITS FOR SAFE DRY CLEANING



Year after year, the safety of commercial dry cleaning with 140° flash-point, petroleum solvent has been proved by Hoffman equipment. Hoffman originated the process in 1935 and, ever since, has been the leading supplier of 140° F dry cleaning systems in the field. On inspections, or permits, or wherever else you see the name "Hoffman", you can be sure it's the safety first-name in equipment for petroleum dry cleaning.



U. S. HOFFMAN MACHINERY CORPORATION
105 Fourth Ave., New York 3, N.Y.
DRY CLEANING, LAUNDRY & GARMENT PRESSING EQUIPMENT

FOR FLAMMABLE LIQUID AND ELECTRICAL FIRES

ANSUL MODEL 30

PIONEERS OF DRY CHEMICAL ANSUL FIRE EXTINGUISHING EQUIPMENT

DRY CHEMICAL

FIRE EXTINGUISHERS

ARE YOUR *BEST* PROTECTION

...and most economical, too! Tests conducted by impartial, nationally recognized approval laboratories have proved the superiority of Ansul Dry Chemical Fire Extinguishers on *Flammable Liquid Fires.*

In addition, Ansul Fire Extinguishers provide greater safety for the operator. The stream of Ansul Dry Chemical forms a protective screen safeguarding him against radiant heat.

More and more industrial plants, transportation companies, oil companies, etc. are switching to Ansul Extinguishers as their first line of fire defense. There is a reason.

Get the facts. Send for your copy of File No. 435. You'll also receive our latest literature together with comparative rating charts for the various types of fire extinguishers.

- Safe for use on electrical fires, too! Even high voltages are not conducted by dry chemical streams.
- Can be recharged at point of fire furnishing continuing protection.
- Annual recharging is not necessary. Low maintenance costs.
- Longer range stream of dry chemical is effective in winds and drafts.
- Ansul Dry Chemical is non-abrasive, non-corrosive, non-toxic.
- Listed and Approved by Underwriters Laboratories and Factory Mutual Laboratories.

ANSUL CHEMICAL COMPANY

FIRE EXTINGUISHER DIVISION, MARINETTE, WISCONSIN

DISTRIBUTORS IN PRINCIPAL CITIES IN THE UNITED STATES, CANADA, AND OTHER COUNTRIES

"Eternal Vigilance"

—THE PRICE OF SECURITY!

WHETHER IT BE NATIONAL OR INDIVIDUAL PERFORMANCE . . . SECURITY IS ACHIEVED ONLY BY THE EVER-ALERT, EVER-CAPABLE AND EVER-DEPENDABLE!

All of these requisites for SECURITY against loss of life and property by fire are provided through the "ETERNAL VIGILANCE" of

STAR AUTOMATIC SPRINKLERS

Automatic Sprinklers
Corrosion-Proof Sprinklers
Directional Flow Sprinklers
Open Sprinklers
Spray Sprinklers
Alarm Devices

Automatic Releases
Standard Wet Pipe Systems
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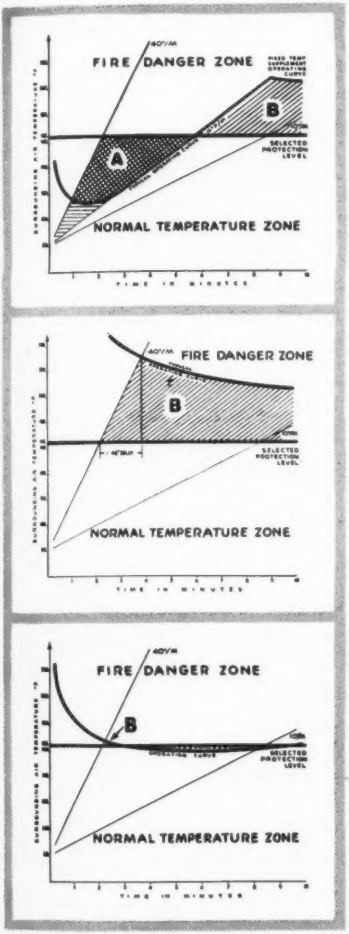
Star Automatic Sprinklers and Fire Protection Devices bear approval of all Insurance Authorities having jurisdiction and various Governmental Agencies.

Economy in installation cost and maintenance has dictated the consistent policy of Star Sprinkler Corporation in distributing its Fire Protection Devices through local licensed contractors who have had a lifetime of experience in the installation of automatic sprinkler systems. Operating throughout the United States, Canada and South America, Star licensees, due to their strategic locations, can render instant service. Write us for name and address of Star licensed contractor nearest your location.

STAR SPRINKLER CORP.

Westmoreland and Collins Sts. — Philadelphia, Pa.



Charts show how only DETECT-A-FIRE signals instantly!

RATE-OF-RISE DETECTOR has serious *false alarm* zone (a) dangerous unprotected zone (b) even with fixed-temperature supplement.

FIXED-TEMPERATURE DETECTOR permits wide unprotected zone (b) due to thermal lag.

DETECT-A-FIRE makes unprotected zone negligible (b) does away with false alarms.

No false alarms!

No unprotected zone!

No thermal lag!

Approved by Factory Mutual Laboratories, Listed by Underwriters' Laboratories, Inc., for Ordinary and Hazardous Locations Class I, Group D; Class II, Groups E, F and G.

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DETECT-A-FIRE

Combines Fixed-Temperature Response with Rate-Of-Rise Compensation for Instant Alarm

SENSITIVE... *but only to heat*

FREE bulletin gives you complete details on amazing Detect-A-Fire. See how you, too, can improve your fire alarm and extinguishing systems. Just mail coupon.

NAME.....POSITION.....

COMPANY.....

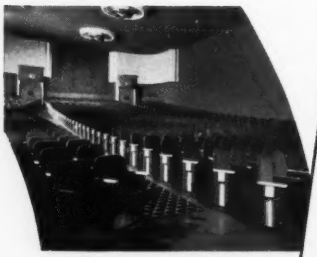
STREET.....

CITY.....ZONE.....STATE.....

FENWAL INCORPORATED, 30 Pleasant Street, Ashland, Massachusetts
Temperature Control Engineers

TOLEX

FIRE-RESISTANT UPHOLSTERY AND APPOINTMENTS FOR GREATER PUBLIC SAFETY WHEREVER PEOPLE CONGREGATE

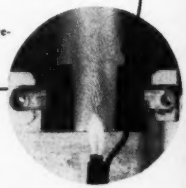


TOLEX F. R. (plastic leathercloth certified to be fire resistant by New York City, Boston and other large communities) gives a rich new look to the interior appointments of theaters, hotels, bars—apartment buildings, department stores, restaurants—railroad cars, buses, watercraft—any place where people congregate. For upholstery, wall coverings and other interior decoration, TOLEX means colorful lasting beauty and super-toughness.

We will gladly send a member of our technical staff to discuss fire-resistant leathercloth specifications and test methods with fire marshalls, fire departments, fire prevention boards or underwriters. Write Textileather Corporation, Toledo, Ohio.

TEXTILEATHER*
NOT LEATHER

PIONEERS IN THE DEVELOPMENT OF FIRE-RESISTANT LEATHERCLOTH

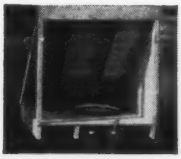


Flame tests demonstrate the fire-resistant qualities of TOLEX.

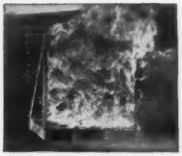
TOLEX* CAN TAKE IT!

*Reg. U. S. Pat. Off.

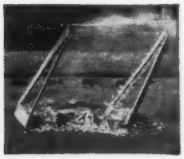
TESTS CONFIRM...



Test structures built of Koppers fire-retardant wood (left) and untreated wood (right) ready for the fire test. Five quarts of kerosene, placed in pans, furnishes fuel for each blaze.



Both structures are quickly enveloped in flame. Treated structure resists fire, but untreated one encourages it, contributes fuel to the fire.



After twenty-two minutes the untreated structure, still burning, is collapsing. Note that in the treated structure, the fire stopped when the fuel burned out.

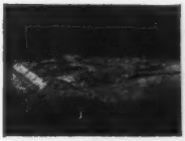
fire retardance of KOPPERS CZC(FR)

Koppers fire-retardant wood is suitable for use as flooring, roofing, sheathing and structural members of industrial buildings, garages, airplane hangars, munitions plants, docks and warehouse buildings, railroad engine houses, and other similar structures. Koppers CZC(FR) treatment has a valuable plus advantage, for it also fortifies the wood against decay and termite attack. Color and paintability are not harmed by the odorless CZC(FR) treatment.

Investigate the possibilities of this new Koppers development. Send for your copy of the booklet, "Koppers Fire-Retardant Wood." Filled with interesting, helpful information.

Right · The treated structure was charred . . . but retained its integrity and strength, as the 800 pound load shows.

Left · Continued burning reduced the untreated structure to ashes.



KOPPERS

KOPPERS PRESSURE-TREATED WOOD

KOPPERS COMPANY, INC.
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GUARDIAN OF STORAGE TANK SAFETY

"VAREC" *Approved* Conservation Vent Unit—Fig. No. 58A—guards the vital petroleum products of one of the largest Canadian Refineries.

"VAREC" *Approved* Conservation Vent Units are "Standard" in many refineries throughout the world. Always on the alert to protect the vital resources of the petroleum and chemical industries, these units are the breathing apparatus of storage tanks.

The valve is completely streamlined and is equipped with inside flame snuffer. Specially designed hyperbolic inner valves are less affected by kinetic energy of velocity flow as they operate at the predetermined static pressure, resulting in greater flow capacity with less "blow-down." These units are non-corrosive in most gases and impervious to the attack of sulphurous gases. They require less maintenance. There is less tendency to freeze. Tank Vent Area is always protected from fire. The conservation of valuable "light-ends" soon turns its cost into dividends.

Fully listed by the Underwriters' Laboratories, and approved by the Associated Factory Mutuals Laboratories and other safety authorities, these Vent Units are truly "Guardians of Storage Tank Safety."

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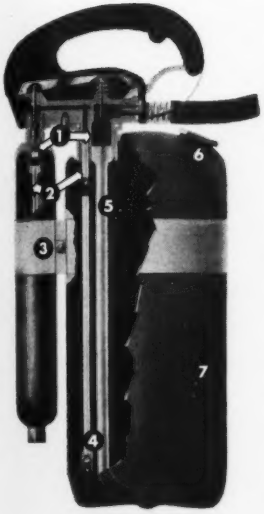


A New DRY CHEMICAL EXTINGUISHER with Trigger-Finger Control

(nothing new to learn)

Here, at last, is an extinguisher that's designed *right* to make the most effective use of an effective fire-extinguishing agent. *Kidde* Dry Chemical Extinguishers—made in 20- and 30-pound capacities—are operated simply by pulling a trigger—the same familiar, time-tested method used on all *Kidde** carbon dioxide (CO_2) extinguishers. *Also known as "Lux"

PLUS these 10 other Big Features!

1 *Simultaneous opening of CO_2 and powder valves.* No trapping of gas pressure in powder chamber *before* the discharge starts.

2 *Quicker transfer of pressure to powder chamber.* Siphon tube carries CO_2 to outlet in powder chamber, where it expands to a gas.

3 *CO_2 cartridge easily replaced.* Just loosen name band holding cartridge—then unscrew cartridge. Same size cartridge for both 20- and 30-pound extinguishers.

4 *CO_2 fluffs up powder—prevents packing.* Small port at bottom of CO_2 outlet tube allows gas to stir up powder.

5 *Powder discharges from top through siphon.* No danger of packing at hose connection.

6 *Powder filler cap needs no tools.* Unscrews easily for refilling of extinguishers in the field. Filler cap is safety-vented.

7 *Lightweight cylinder for ease of carrying.* Pound for pound, the *Kidde* Dry Chemical Extinguisher packs more fire-fighting punch!

8 *Better powder dispersion pattern.* Diffusion baffle in horn gives greater coverage, more effective application. No shut-off valve in horn to trap powder under pressure in hose. No rodding out of hose after use.

9 *Extinguisher tested for operation at —40° F.*

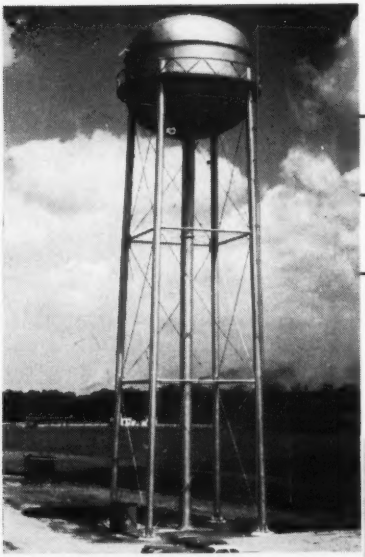
10 *Improved powder and packaging.* Powder specially processed to make it free-flowing; packed in weatherproof containers. 30-pound carton contains three 10-pound cans—for easy refilling of either 20- or 30-pound extinguishers. 50-pound containers also available.

Write for full details

Kidde

The words "Kidde" and "Lux" and the Kidde seal are trade-marks of Walter Kidde & Company, Inc.

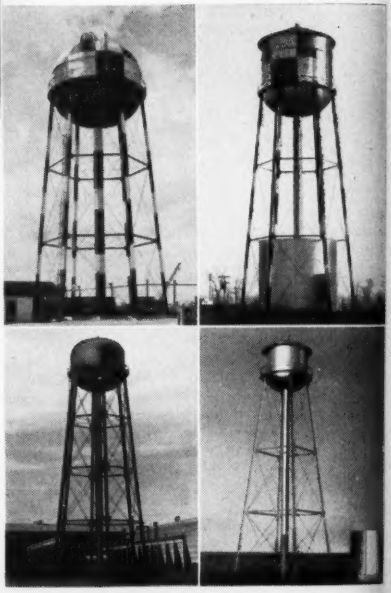
Walter Kidde & Company, Inc., 1051 Main Street, Belleville 9, N. J.



BETTER FIRE PROTECTION . . .

BETTER WATER SERVICE . . .

BETTER LONG-TERM ECONOMY...



with

PITTSBURGH •DES MOINES

Elevated Steel Tanks

Ever-present fire protection combines with completely dependable water service for general plant use—including storage of cooled water and other process applications—to create immediate value in your Pittsburgh-Des Moines Elevated Steel Tank. Year-after-year durability and low maintenance costs are P-DM values that steadily enhance your investment. *May we give you the details?*

PITTSBURGH • DES MOINES STEEL CO.

Plants at PITTSBURGH, DES MOINES and SANTA CLARA

Sales Offices at:

PITTSBURGH . . . . . 3468 Neville Island
NEW YORK . . . . . Room 950, 270 Broadway
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DALLAS . . . . . 1273 Praetorian Bldg.
SEATTLE . . . . . 975 Lane Street

The layman still needs to be told . . .

—and to have it everlastingly repeated:

1. Forty-three per cent of burned out businesses never re-open their doors!
2. Bad fires can and do occur even in so-called "fire-proof" buildings.
3. Insurance premium savings more than pay for sprinkler installation.

Telling the layman these important things is a job for *all* fire protection men.

Blaw-Knox Fire Protection Systems include Standard Wet or Dry Pipe Systems, Fog Nozzles for Fixed Installations, Thermostatically Controlled and Supervised Deluge Systems, and special fittings for special conditions.*

**Listed by Underwriters' Laboratories, Inc., and approved by Factory Mutual Laboratories.*

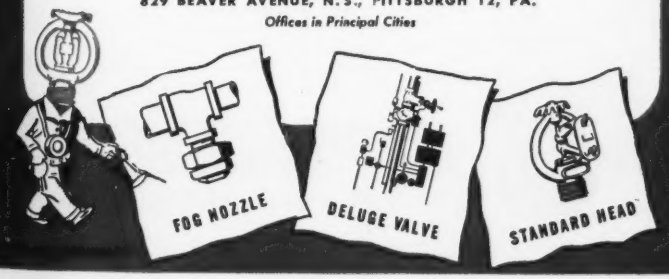
BLAW-KNOX

SPRINKLER DIVISION

OF BLAW-KNOX CONSTRUCTION COMPANY

829 BEAVER AVENUE, N. S., PITTSBURGH 12, PA.

Offices in Principal Cities



EASIER FIRE FIGHTING FOR YOUR EMPLOYEES!

with

Randolph

Trigger-Touch Carbon Dioxide Fire Extinguishers

Your employees are your *real* fire-fighters . . . and the fire extinguisher is their most powerful weapon. That's why it's important that you eliminate cumbersome, antiquated extinguishers . . . provide them with easy-to-use equipment.

Just ONE HAND snaps the Randolph Extinguisher from its bracket . . . one trigger-touch sends clouds of penetrating, snowy carbon dioxide into the fire . . . stops the most stubborn blaze in *split-seconds!*

With no valves or nozzles to adjust, Randolph Extinguishers are PANIC-PROOF — get the employee to the blaze before it spreads. A non-toxic, odorless gas, carbon dioxide does not damage equipment or conduct electricity. It leaves no stain or liquid; will not freeze or deteriorate.

All Sizes . . . Underwriters Approved

Randolph Trigger-Touch Extinguishers are available in 2, 4, 10, 15 and the big 25 lb. size on wheels . . . every unit approved by Underwriters' Laboratories. Mobilize *your* first-aid fire defense now! For complete fire protection facts or test demonstrations, write . . .

RANDOLPH LABORATORIES, INC.

24 E. Kinzie Street

Chicago 11, Illinois

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29 YEARS OF SUPERIOR SERVICE

Prove

Your BEST PROTECTION against the fury of FIRE is a

CENTRAL AUTOMATIC SPRINKLER SYSTEM

Whether it be a wet pipe system or a dry pipe system — or perhaps a Central "Electro-Speed" Deluge Sprinkler System, you will find the one BEST TYPE is a CENTRAL SPRINKLER SYSTEM.

They pay for themselves in insurance savings.

Write us for information.

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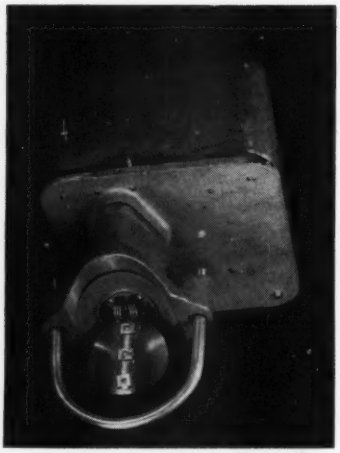
Main Office and Plant
Fourth Street and Cannon Avenue
LANSDALE, PA.

(Representatives in principal cities in United States, Canada and foreign countries)

"Central Sprinklers answer the burning question"

★ ★ ★



3-inch size shown above. To install simply drill hole in pipe.

CENTRAL STATION SIGNALS, INC.

Model PRS

Waterflow Alarm Device was approved by the Underwriters' Laboratories, Inc., last year and has proven in hundreds of installations to be the ideal alarm device for sprinkler systems.

- **Made in all sizes from 2½" to 8"**
- **It is positive in operation**
- **Has instantly recycling pneumatic retarding device which prevents false alarms**
- **Has enclosed electrical contacts for 15 amp, 125 volts AC and ½ amp, 125 volts DC**
- **Relay may be provided for any electrical load**
- **Can be furnished in open or closed circuit**

By installing this most economical alarm device, you will know instantly where the water is flowing. Many plants are having them installed on each floor or in each section. They save water damage.

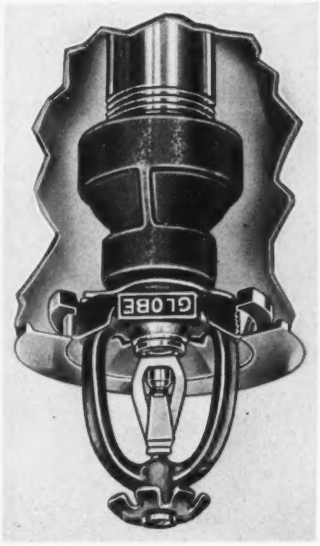
This device can also be obtained as Model PRT, a coded waterflow transmitter from which signals are received on a punch register and single stroke gong. Practically any number can be installed on a two-wire system, thus resulting in considerable savings on wiring.

WE SOLICIT YOUR INQUIRIES

CENTRAL STATION SIGNALS, INC.

Manufacturers of all kinds of approved devices used in Central Station Systems or Class 'A' or Class 'B' Proprietary Fire Alarm Systems, either automatic or manual.

71 WEST 23rd STREET -:- NEW YORK 10, N. Y.



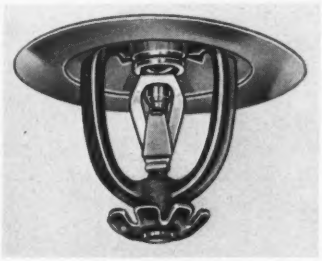
What's **DIFFERENT**
about
Globe Protection!

FOR EYE APPEAL
Under Decorative Ceilings

SAVEALL
FLUSH TYPE SPRINKLER

Designed Simplicity
Practical and Economical

Where appearance is paramount, as in Hotel Lobbies, Dining Rooms, Offices and Sales Areas.



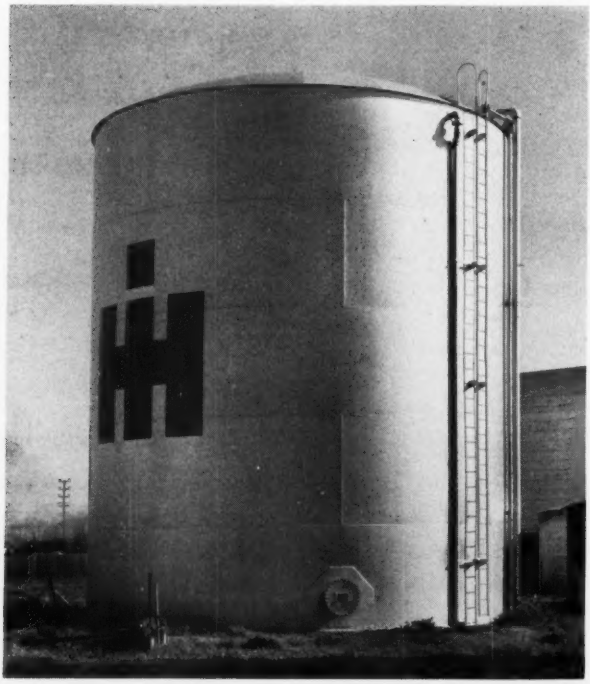
A Standard Saveall Sprinkler Inset in the Ceiling. Easy to install and to replace after a Fire.

GLOBE AUTOMATIC SPRINKLER CO.

2035 WASHINGTON AVE. **PHILADELPHIA 46, PA.**

Sales Offices in Principal Cities.

GUARDING AGAINST FIRE



The Horton welded steel tank shown above stands ready to safeguard the Stockton, Calif., plant of the International Harvester Company against fire damage. The 200,000 gallons of water in the tank is the secondary supply for the automatic sprinkler system at the plant. Should the pressure in the city water mains drop too low to supply the sprinkler system, the water in the tank will automatically be pumped into the sprinkler line the moment a sprinkler head opens.

Whenever you need a flat-bottom or elevated water storage tank, write our nearest office for a quotation.

CHICAGO BRIDGE & IRON COMPANY

CLEVELAND	CHICAGO	BIRMINGHAM	NEW YORK
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HOUSTON	TULSA	LOS ANGELES	SAN FRANCISCO
CARACAS	BOSTON	SEATTLE	SALT LAKE CITY

Plants at Chicago, Birmingham, Salt Lake City and Greenville, Pa.

THIS IS THE THIRD, MR. INSPECTOR,

of a series of illustrations showing the various types of panic exit devices in most frequent use. The photograph below shows a rim type device, the best kind for most single door installations. The door shown here is on the Dr. Zina Pitcher School, Detroit: George D. Mason & Co., Architects.

VON DUPRIN DIVISION
VONNEGUT HARDWARE CO., INDIANAPOLIS 9, INDIANA
In Canada, write Yale & Towne Mfg. Co. (Canadian Div.), St. Catharines, Ont.

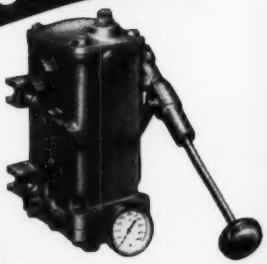
CHANCE — or SECURITY?

When you are delivering liquid petroleum fuels or liquefied petroleum gases, you just cannot afford to take chances with fires which frequently accompany highway accidents, and are sometimes occasioned by a carelessly tossed match or cigarette when tanks are being unloaded.

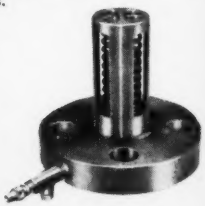
Petroleum transporters who insist upon the utmost in SAFETY, have for years equipped their petroleum truck tanks with S. & J. Internal Hydraulic Safety Valve Systems, the principal components of which are here illustrated. Everyone knows that hydraulic pressure is positive and dependable—it either works or it doesn't work.

You can't open S. & J. hydraulic valves without pumping up pressure. When that pressure is released, either by the operator or by the melting of the fusible plugs in the hydraulic lines, the valves close instantly by spring tension. If you are not familiar with this system, write us for a catalog and prices.

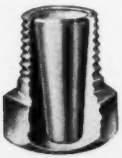
SHAND & JURS CO.
BERKELEY, CALIFORNIA



The hydraulic operator is a pump which actuates the internal safety valves.



This is the model of hydraulic internal safety valve used in discharge lines of butane and propane trucks.



This fusible plug melts at 165°F., releases pressure, automatically closing valves in event of fire when valves are open.

NEW YORK CHICAGO HOUSTON LOS ANGELES SEATTLE

SHAND & JURS

RELIABLE

AUTOMATIC SPRINKLER DEVICES

PROTECTING LIFE AND PROPERTY FOR OVER 25 YEARS

Reliable Automatic Sprinkler Devices have an excellent field record . . . superb in design and construction . . . are universally approved by all Fire Insurance and Governmental Authorities . . . and effect maximum reductions in fire insurance premiums.

They comprise a complete line including Automatic and Open Sprinklers, Alarm Valves, Dry Pipe Valves, Accelerators, Circuit Closers, Water Motors and all other accessories required in Sprinkler Systems.

Reliable Systems are protecting thousands of properties throughout the United States, Canada and foreign countries.

FURTHER INFORMATION UPON REQUEST

Manufactured and Distributed by

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BRONX STREET — MOUNT VERNON, N. Y.

REGO
LP GAS EQUIPMENT

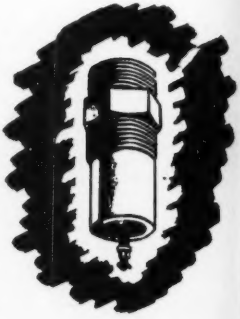
Specified For...

PERFORMANCE PLUS SAFETY!

Here's Why:

- It is listed by Underwriters' Laboratories
- It conforms to N.F.P.A. Standards
- It is manufactured only after thorough field testing
- It is shipped only after being rigidly inspected and tested at the factory

Typical of the many RegO-designed devices for insuring the safe use of LP Gases are RegO Excess Flow Check Valves. These valves, which shut off the flow of fuel should a break in the line occur, may be used with butane or propane in either a gaseous or liquid state. They function with complete efficiency whether mounted vertically or horizontally. A complete range of sizes provides valves suitable for every use, from small domestic installations to large bulk plant or industrial applications.



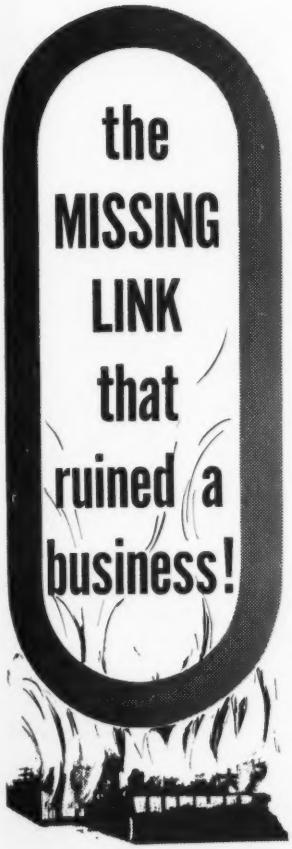
RegO Excess Flow Check Valves

REGO LP GAS EQUIPMENT

The BASTIAN-BLESSING Company

4201 West Peterson Avenue Chicago 30, Illinois

PIONEER AND LEADER IN THE DESIGN AND MANUFACTURE OF PRECISION EQUIPMENT FOR USING AND CONTROLLING LP GASES



This company was one of the leaders in its industry.

Its very name evoked a sense of quality and established acceptance.

Labor relations were happy. All departments functioned in creative harmony.

It employed a Watchman. It carried Insurance.

But in five hours, the work of a lifetime was reduced to a smoking shambles.

What went wrong?

If you are a management executive, you owe it to the continued security of your own company to get the answer. It may prevent a sudden and tragic occurrence in your own enterprise.

"STORY OF THE MISSING LINK" has been published by DETEX as both a warning and guide to executives who are charged with the responsibility of plant protection. Send for it. It's free.

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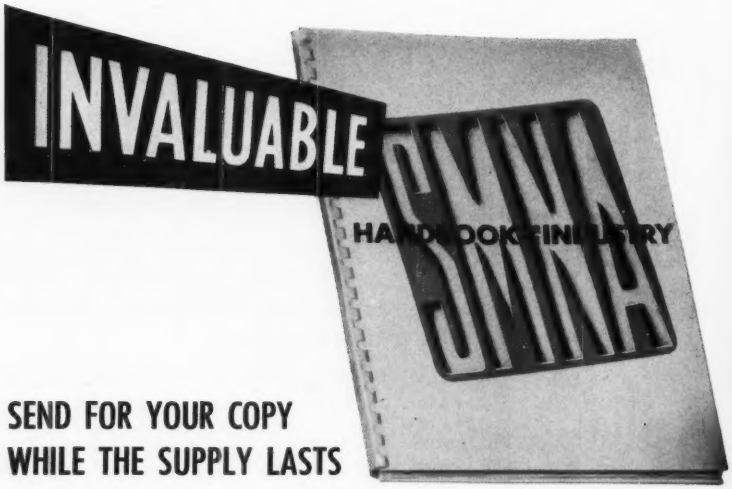
76 VARICK STREET, NEW YORK 13, N. Y.
Sales and Service in All Principal Cities



**SEND FOR YOUR COPY
WHILE THE SUPPLY LASTS**

This new Manual is the most authoritative and thorough volume ever compiled on the subject of record-protection equipment. An indispensable reference book, well-organized, easy to use. 76 pages of pertinent information concerning the specifications, tests and specific applications of rated safe-industry products; gives aids for measuring fire hazards and record protection needs and other essential data.

Price $1

In The Background Till Fire Strikes

Fits in smoothly with the most modern interiors. Barely visible, but ready at a second's warning to spring into action. Viking Flush Type Sprinkler Heads offer great *dependability*, plus true functional design. Get all details today from the *Viking* representative in your neighborhood.

THE VIKING FLUSH TYPE SPRINKLER HEAD

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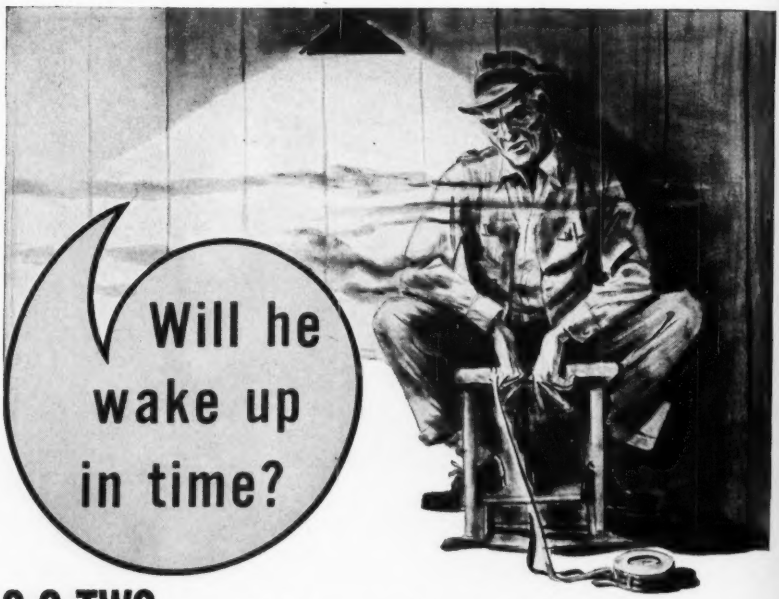

C-O-TWO is a 24 hour a day automatic fire watchman

We're all human . . . we all slip up now and then. One of these slips can cost you your business . . . especially at night when a little fire could be unnoticed for hours.

Round-the-clock automatic fire protection is the modern way to keep your business firesafe. The C-O-TWO Combination Smoke Detecting and Fire Extinguishing System is wide awake and on the job constantly. The first whiff of smoke in a protected area sounds an alarm. Then fast, clean, non-damaging carbon dioxide blankets the fire, putting it out in seconds, before it spreads and causes extensive damage.

C-O-TWO manufactures and installs fire protection systems for one, two, twenty-four, sixty or any number of enclosed or semi-enclosed spaces. Let an expert C-O-TWO Fire Protection Engineer help you plan modern, dependable, fully approved fire protection for your property now, before fire strikes. Remember . . . tomorrow may be too late. Write us today for complete information.

C-O-TWO

C-O-TWO FIRE EQUIPMENT COMPANY
NEWARK 1 • NEW JERSEY
Sales and Service in the Principal Cities of United States and Canada
AFFILIATED WITH PYRENE MANUFACTURING COMPANY

KINNEAR
ROLLING FIRE DOORS

Ask the men who *fight* fires—and the men who investigate fire losses. They have seen how effectively Kinnear Rolling Fire Doors block the spread of flames at doorways, corridors, elevator shafts and other openings. They have seen them literally trap fires within small areas . . . save whole wings or sections of buildings from loss . . . protect buildings erected wall-to-wall beside structures totally demolished by fire. And records show that in at least 40 per cent of all major fires, in an average year, lack of adequate fire-door protection contributes to the heavy fire losses.

You can be sure of protection at all windows, doorways, and other openings with "AKBAR" Steel Rolling Fire Doors, an exclusive, time-tested Kinnear product labeled by Underwriters' Laboratories Inc. In many cases, they've paid for themselves in two or three years, through reduced insurance rates.

These doors remain out of the way, overhead, when not in use. They may even be concealed in the wall, above the lintel. But when fire threatens, their exclusive operating features assure quick, automatic, positive, safe closure.

Kinnear "Akbar" Rolling Fire Doors are highly efficient in daily service use, too, and may be equipped for convenient motor operation if desired. Available in any size, for any type of opening. Write for complete information on Kinnear Rolling Fire Doors.

Saving Ways in Doorways
KINNEAR
ROLLING DOORS

The KINNEAR Manufacturing Co.
Factories: 2250-70 Fields Ave., Columbus 16, Ohio
1742 Yosemite Ave., San Francisco 24, California
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VAPORIZING LIQUID

The all-purpose extinguisher effective on almost every kind of fire. Safe on electrical fires, too! 1 qt. and 1½ qt. pump types; 2 qt. (above) and 1 gal. pressure-operated types.

AIR FOAM

Couple playpipe to hose line. Every 19 gals. of water and 1 gal. of PYRENE Foam Compound yield 350 gals. of foam! For flammable liquids and ordinary combustibles.

CARTRIDGE-OPERATED

Eliminates annual recharging. For fires in wood, paper, textiles, and the like. Shoots a steady 40 ft. stream of water or antifreeze solution. 2½ gal. size.

ALSO MANUAL AND AUTOMATIC SYSTEMS; CHEMICAL FOAM, SODA ACID, PUMP TANK, AND OTHER FIRE EXTINGUISHERS

Get one or all- with one jobber call

Your PYRENE jobber can save you time and money!

Your local PYRENE* jobber carries various types of PYRENE Fire Extinguishers *in stock*. You don't have to wait for delivery of your extinguishers, and you don't need to pay freight charges from the factory. Because there is a PYRENE for every fire hazard, you can *centralize* your extinguisher buying. One call to your jobber, one purchase order, and one invoice will take care of everything. Write for address of your local PYRENE jobber.

*T.M. Reg. U.S. Pat. Off.

PYRENE MANUFACTURING COMPANY

582 Belmont Ave. Newark 8, N.J.

Affiliated with C-O-Two Fire Equipment Co.

13,000 Copies Sold!

Do You Have Yours?

The Tenth Edition of the "N.F.P.A. Handbook of Fire Protection" was published little more than a year ago, yet in that time over 13,000 copies have been sold. This exceeds all previous records for the sale of this well-known reference book and attests to its broad usefulness.

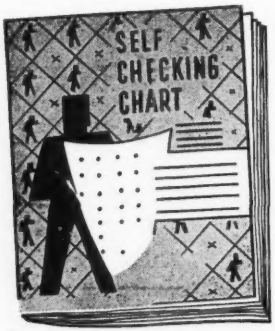
Tremendous advances in fire protection have been made in every branch of the fire engineering field since the Ninth Edition of the Handbook in 1941. The Tenth Edition contains new and up-to-date information, a good deal of which represents developments that were made during the war — in industry, in fire prevention and in fire extinguishment.

The Handbook is the basis of education for beginners in the fields of fire protection and fire prevention, and is the constant companion of experienced men specializing in these fields. It is an invaluable reference work for those occasionally requiring specific facts of this character. In keeping with the purpose of a reference book, all information is presented clearly, concisely and as far as possible in non-technical language.

Attractively and solidly bound in red fabrikoid, the 5½″ x 7½″ Handbook contains 1,544 pages, 897 illustrations, and 321 tables. $9.50 per copy.

NFPA

NATIONAL FIRE PROTECTION ASSN.
INTERNATIONAL
60 Batterymarch St., Boston 10, Mass.



another PROTECTOSEAL SERVICE

of interest to professional people engaged in fire prevention

New "Self-Checking Chart"

Protectoseal extends a helping hand to American industry. Free for the asking . . . it's called the "Self-Checking Chart." It is a tool to help plant managers and those responsible for fire safety to make inspections of their property with greater speed and assurance.

Handy Departmental Guide

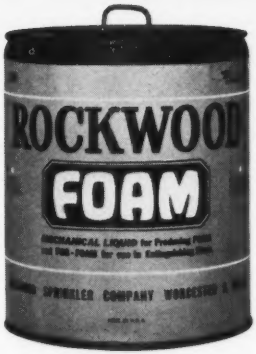
The "Self-Checking Chart" is a guide that points out places to look for specific hazards. It is a check list of points of danger. Specifically it refers to the handling, storing, and dispensing of flammable liquids, but it is packed with fire-facts and good tips on housekeeping and fire prevention. A complimentary copy will be sent upon request.

Valuable Inspection Service

All facilities of *Protectoseal*, its engineers, its field inspectors, its educational bureau are available (without obligation) to anyone interested in reducing the loss of life and property by fire. Some phases of the *Protectoseal* program — reprints of informative ads, booklets, catalog materials and this new technique for plant inspection — may perhaps be of value in your work. They are all yours free of charge.

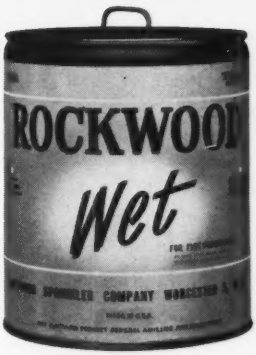
THE PROTECTOSEAL COMPANY
1972 SOUTH WESTERN AVENUE, CHICAGO 8, ILLINOIS

CUT YOUR Fire Fighting COST WITH ROCKWOOD'S MODERN CHEMICALS



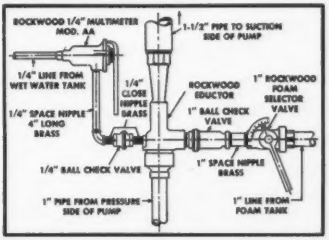
Use Rockwood Foam Liquid to fight fires in gasoline and in other similar flammable liquids. It is a low expansion, protein base foam liquid. By mixing six parts of Rockwood Foam Liquid with ninety-four parts of water, you will create an excellent foam blanket with real stability and fire extinguishing qualities. To put out fires faster and more economically use Rockwood Foam Liquid with the new Type FFF Rockwood Fog-FOAM Nozzle.

FFF
Fog FOAM
NOZZLE

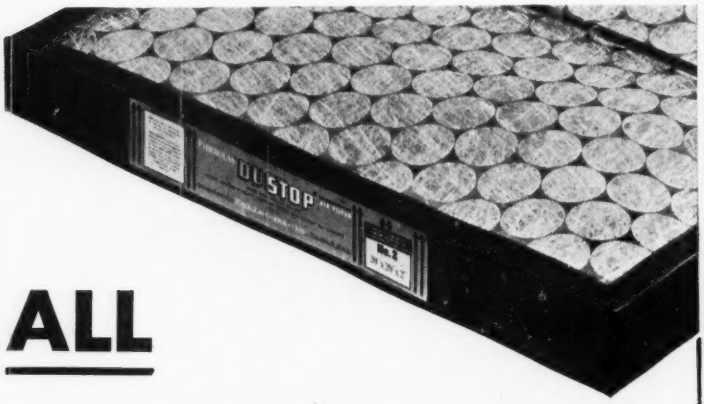


Rockwood "Wet" speeds the spread and penetration of water into deep seated fires involving ordinary combustibles such as wood, paper, cloth, etc. Use one part Rockwood "Wet" with ninety-nine parts of water to reduce the time, man power and quantity of water needed to put out fires. Rockwood "Wet" is less corrosive than water.

New Rockwood Model B Automatic Proportioner for your fire trucks — pays for itself by automatically feeding foam liquid or wetting agent into hose lines. Eliminates waste.


ROCKWOOD 1/4" MULTIMETER MOD. AA
1-1/2" PIPE TO SUCTION SIDE OF PUMP
1/4" LINE FROM WET WATER TANK
1/4" CLOSE NIPPLE BRASS
ROCKWOOD EDUCTOR
1" ROCKWOOD FOAM SELECTOR VALVE
1/4" SPACE NIPPLE 4" LONG BRASS
1" BALL CHECK VALVE
1/4" BALL CHECK VALVE
1" SPACE NIPPLE BRASS
1" PIPE FROM PRESSURE SIDE OF PUMP
1" LINE FROM FOAM TANK

ROCKWOOD SPRINKLER COMPANY
56 HARLOW STREET WORCESTER 5, MASSACHUSETTS
Specialists in Fire Protection Engineering, Equipment and Installation since 1907



ALL

DUST STOP*

*T. M. REG. U.S. PAT. OFF.

AIR FILTERS

ARE LISTED BY

LISTED UNDER REEXAMINATION SERVICE
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UNDERWRITERS' LABORATORIES, INC. OF

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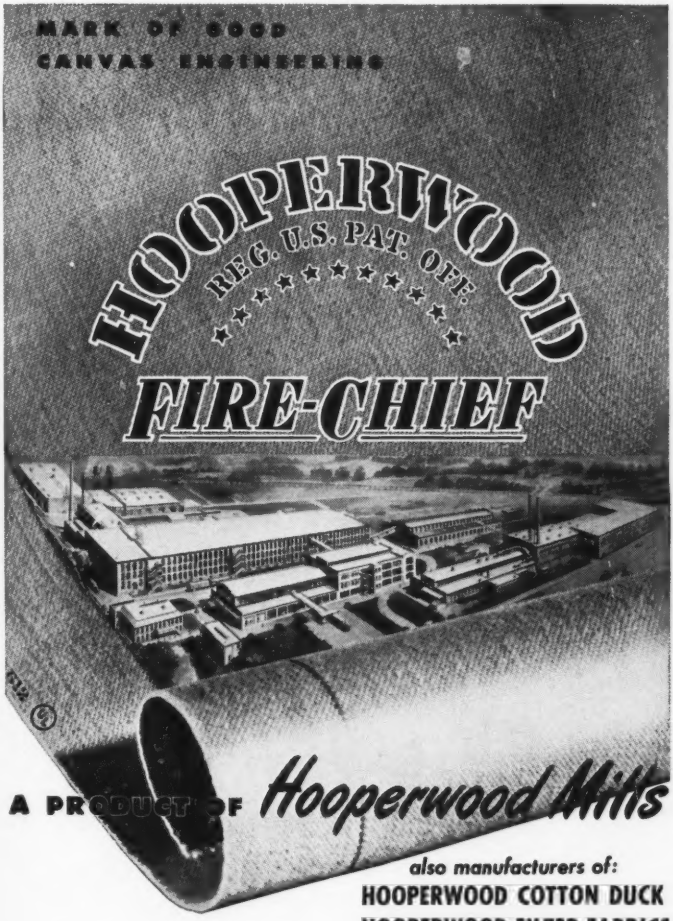
OWENS-CORNING FIBERGLAS CORPORATION
TOLEDO 1, OHIO

*DUST-STOP is the trade-mark of Owens-Corning Fiberglas Corporation for impingement-type air filters made of glass fibers.



A PRODUCT OF *Hooperwood Mills*

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Try this on for size

6⅞ – 7¾ – your headsize doesn't matter!

If your business is insurance – if your aim is community service and recognition–if your target is sound and steady business growth – it will fit you to a "T."

The need for fire prevention work has never been so great as it is today. It is one of the most rewarding jobs any insurance man can undertake. It focuses community attention on your business. It tends to lower fire premiums, making policies easier to sell. It pays dividends out of all proportion to the time demanded–in both personal satisfaction and the kind of community-wide goodwill that builds business.

Fire prevention helps, including motion pictures, posters, talks, and booklets are provided by many companies as well as by The National Board of Fire Underwriters, The National Fire Protection Association and others.

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STANDARD FIRE INSURANCE COMPANY
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Fire and Marine Insurance
All Forms

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VALVES, HYDRANTS Indicator Posts and Pipe Fittings For FIRE PROTECTION

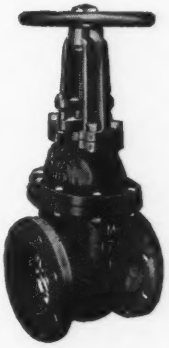
We make a complete line of Valves, Hydrants, Indicator Posts and underground pipe fittings for fire protection systems. All M&H products are approved and listed by the Underwriters' Laboratories and A.F.M. Laboratories. Outstanding features are simplicity of design, rugged construction and highest quality materials and workmanship. Write for CATALOG No. 40. On your orders specify M&H for service.

Top, Left: Swing Check valve.

Above: Tapping Sleeve and valve to tap a main under pressure.

Right: Rising Stem Gate Valve, bronze mounted.

Below, Right: Mill Yard Hydrant, Independent Hose Gate Valves.

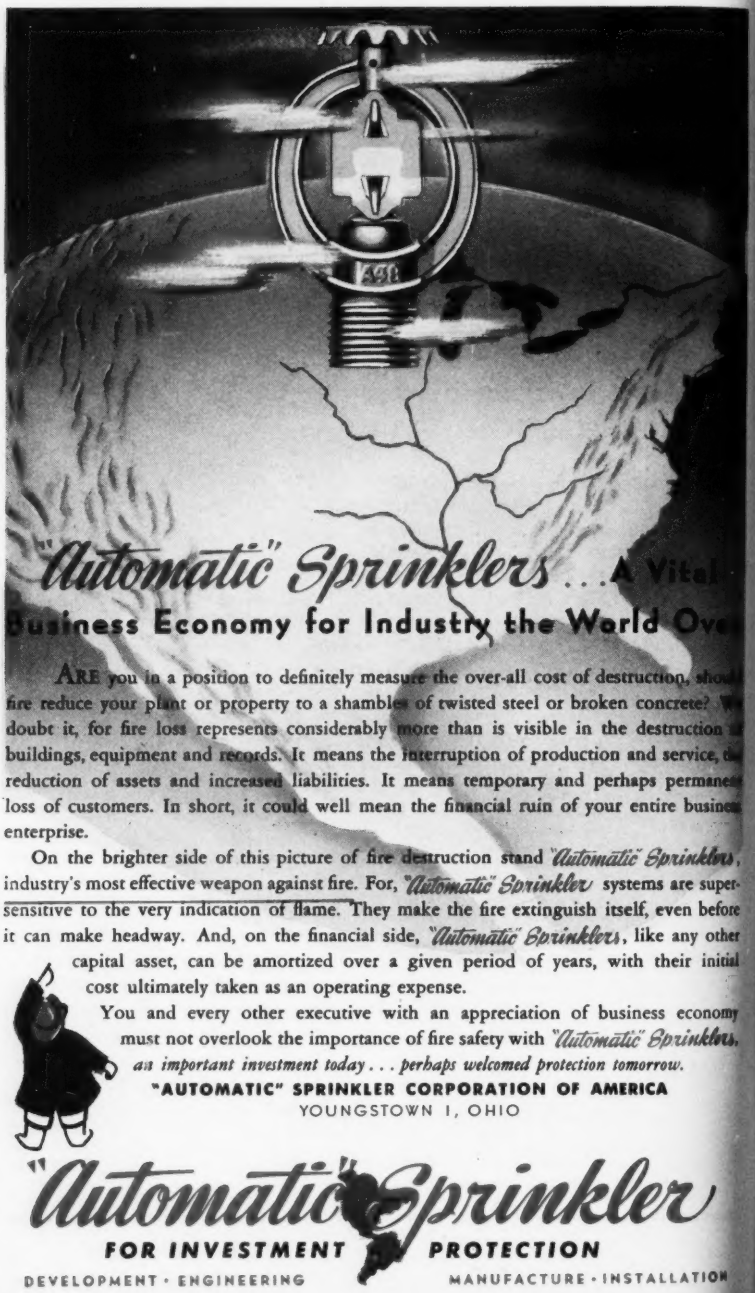


Left: Adjustable Indicator Post.

MECHANICAL JOINTS

In addition to regular hub ends and flanged ends, M&H Valves and Hydrants are now furnished with stuffing-box type Mechanical Joints for use with Standardized Mechanical Joint cast iron pipe.

M&H VALVE
AND FITTINGS COMPANY
ANNISTON, ALABAMA


"Automatic" Sprinklers . . . A Vital
Business Economy for Industry the World Ove
ARE you in a position to definitely measure the over-all cost of destruction, shou
fire reduce your plant or property to a shambles of twisted steel or broken concrete? W
doubt it, for fire loss represents considerably more than is visible in the destruction
buildings, equipment and records. It means the interruption of production and service, t
reduction of assets and increased liabilities. It means temporary and perhaps permane
loss of customers. In short, it could well mean the financial ruin of your entire busine
enterprise.
On the brighter side of this picture of fire destruction stand "Automatic" Sprinklers,
industry's most effective weapon against fire. For, "Automatic" Sprinkler systems are super-
sensitive to the very indication of flame. They make the fire extinguish itself, even before
it can make headway. And, on the financial side, "Automatic" Sprinklers, like any other
capital asset, can be amortized over a given period of years, with their initial
cost ultimately taken as an operating expense.
You and every other executive with an appreciation of business economy
must not overlook the importance of fire safety with "Automatic" Sprinklers.
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FOR INVESTMENT PROTECTION
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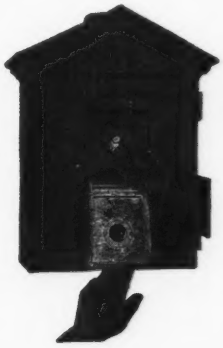
WHY CITIES PREFER GAMEWELL

2 Reasons are—Economy and Dependability

Many Gamewell fire alarm boxes still in use have service records exceeding 70 years, and — Obsolescence, due to the production of later models affording greater protection, not deterioration, is generally the cause of retiring Gamewell boxes from service.



Gamewell Three-Fold Fire Alarm Box

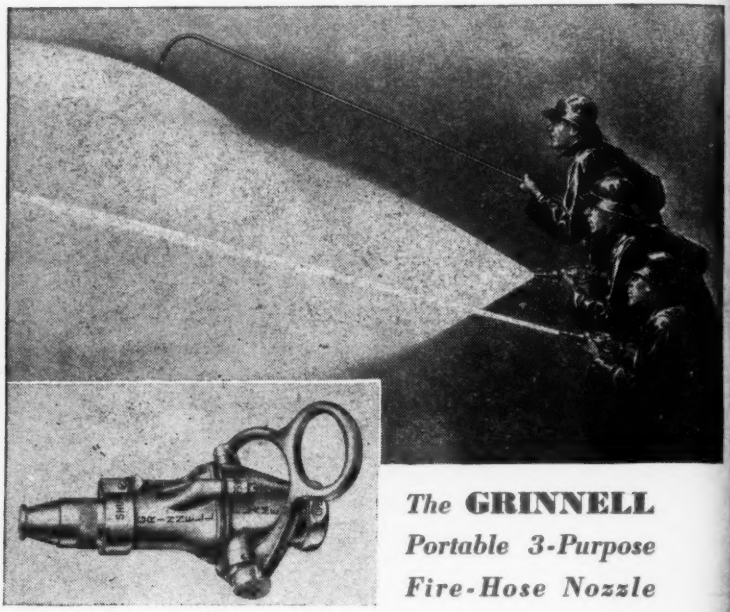
The Standard for Municipal Service

For the protection of the values at risk — human life, property, business and income — adequate fire alarm box distribution is a sound investment.

THE GAMEWELL COMPANY

Newton Upper Falls 64 - Massachusetts

FlameBuster



The **GRINNELL**
Portable 3-Purpose
Fire-Hose Nozzle

FlameBuster permits quick selection of water in the form best suited to extinguish fires in both oils and Class A materials.

The Low Velocity spray, projected by a unique Grinnell tip on a 4′ to 10′ applicator, puts out fires with minimum water consumption in the lighter flammable oils.

The High Velocity spray extinguishes fires in heavier and medium oils by forming with the oil a fire-extinguishing emulsion.

The Solid Stream is for mopping-up operations on wood or similar materials burning beyond the range of spray.

Descriptive folder is available without obligation. Grinnell Company, Inc., Providence 1, R. I., Branch Offices in principal cities.

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For Protection Against Fire

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